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PRINCIPLES OF WATER-POWER DEVELOPMENT[1]

1. The development of water-power involves artificial regulation of streams. Proper regulation of running water for the several uses of water supply, irrigation, power and navigation can be effected only in the light of the physical relations, the relations in equity, and the more salient legal relations of water in streams.

PHYSICAL RELATIONS

2. The fresh water of the land is derived directly from rainfall (including snow) and indirectly through evaporation from the sea. The mean annual rainfall on mainland United States ranges from less than 5 to over 100 inches, averaging 30 inches; the quantity aggregates about 5,000,000,000 acre-feet.[2] The distribution is unequal; over the eastward two fifths of the country the mean is about 48 inches, over the median fifth some 30 inches, and over the westward two fifths about 12 inches.[3]

3. In humid lands the water of rains and melting snows tends to gather into streams, generally taking the shortest and easiest paths to the sea, while in arid lands

[1] Presented at a hearing of the National Waterways Commission, November 21, 1911.

[2] The acre-foot is a convenient unit not only because in common use throughout arid America, but because large enough to measure water in its national aspect without use of incomprehensibly large figures. It equals 43,560 cubic feet, 326,047 gallons, or 1,359.6 tons; it is something over a kilostere (equaling 1.2335 ks.), or cube of 10 meters.

[3] "Soil Erosion," Bureau of Soils Bulletin 71, 1911, p. 17.

(except in a few rivers fed by the greater rain and snow of mountains) it tends to spread into débris-laden sheetfloods and will not flow down to the sea; lakes, in which water lodges for a time, are essentially expansions of streams due to what may be called geologic accidents—*e. g.*, the Great Lakes chiefly to glacial scouring, the Millelacs to the irregular configuration of glacial-drift surfaces, Great Salt and Winnemucca Lakes originally to warping of the earth-crust; waterfalls, in which power is easily developed, are also due to geologic accidents—*e. g.*, Niagara and Genesee and St. Anthony to conditions attending withdrawal of the Pleistocene glaciers, the cataracts of the Susquehanna and Potomac and James and the Dalles of the Columbia to displacement in the earth-crust.

4. In humid regions (including mountains in which rain and snow are more abundant than over neighboring lowlands) the streams carry a part only of the water reaching the surface—*i. e.*, the run-off, averaging about one third of the rainfall; about half the aggregate is evaporated, partly from the soil and open waters though more freely from growing vegetation, forming the fly-off; while a smaller fraction (the cut-off) passes deeply into the earth to be absorbed in chemical combination or carried subterraneously to the sea. In arid regions there is (normally) no run-off, and all the water except the small cut-off is evaporated to temper the local climate.

5. In a state of nature—and also under intensive cultivation—little if any storm water flows over the land surface apart from the streams; the rainfall is absorbed by the soil and its vegetal growth, and the streams are supplied partly by springs but much more largely by seepage directly into their channels—this being the normal condition, in which streams are generally clear and nearly uniform in flow.

6. Under certain conditions attending settlement, especially with injudicious clearing and negligent cultivation, a considerable part of the rain falling during storms runs off the land surface, erodes the soil, renders streams turbid, gathers into destructive floods, and introduces wide fluctuations in flow (this representing what may be deemed a temporary condition in the history of the country, and one remediable by proper classification and use of the lands for purposes to which they are adapted, and by intensive cultivation of areas devoted to the growing of seasonal crops).

7. All parts of each stream are interrelated; increase or decrease in volume, inwash of detritus, the initiation of fluctuation, or other changes in regimen at any point eventually affect the stream throughout; especially susceptible to disturbance at the sources are clarity and steadiness of flow at points whence water supply is commonly taken, in the middle course where power development is customary, and in the lower course devoted to navigation.

8. Normal streams, being derived chiefly from seepage, are maintained directly by the store of water accumulated in the ground as the residuum of rains of preceding seasons and decades, and only indirectly by the current rainfall. In the humid part of this country the ground water within the first hundred feet from the surface has been estimated at some 25 per cent. of the volume of subsoil and rock, equivalent to 6 or 7 years' rainfall—*i. e.*, it may be conceived as a reservoir of water 25 feet deep coinciding in area with the humid region. This reservoir is the chief source of the streams available for water-power and other purposes; it is also the reserve agricultural capital of the country,

and the measure of productivity and habitability.

9. Under extensive clearing and cultivation, the store of ground water has been materially depleted. Recent determinations based on records (covering a mean period of about 22 years) of 9,507 wells in the nine states of Illinois, Indiana, Iowa, Kentucky, Michigan, Minnesota, Ohio, Tennessee and Wisconsin reveal lowering of the water-table at a minimum mean rate of 1.315 feet,[4] or with moderate allowance for new wells 1.73 feet, per decade, corresponding to an aggregate of 13.8 feet for the 80 years since settlement began. This lowering of the level of saturation corresponds with an actual loss of water averaging 5.2 inches per decade, or nearly 150,000,000 acre-feet annually within the nine states. The loss is due largely to increased run-off in freshets and floods, which are in increasing degree wreaking destruction of property and loss of life; while innumerable springs and smaller source streams have disappeared, and the regimen of nearly all streams has been impaired.

10. The rate of subsidence of the water-table varies from state to state; in those enumerated it declines from 2.464 feet per decade in Minnesota to 0.8 foot in Ohio, while in Missouri it is but 0.43 foot. When the variable rates are coordinated with the geographic relations of the several states, it becomes clear that the ground-water reservoir of the entire interior is continuous, that Missouri is supplied in part by underflow from the Plains and Rocky Mountains, that the level in Ohio is kept up in part by seepage from Lake Erie (explaining that discrepancy between inflow and discharge from the lake which has led to excessive estimates of evaporation), and that Minnesota has merely lost proportionately with the absence of external sources of supply—in short that throughout this area of 532,402 square miles (and presumably elsewhere in the humid country) the reserve store of ground water is not only continuous and fairly conformable to the land surface but moves slowly down-slope in directions generally corresponding with those of the surface streams.

11. The recent researches demonstrate that the surface streams of the humid coun-

[4] The records are summarized in the table following; the detail figures appear in the Yearbook of the Department of Agriculture for 1911 under the title "Subsoil Water of Central United States."

State	Dates		Total No.	Wells Mean Depth	Bi-state Wells			Mean Lowering	Water-tables		Mean Lowering per Decade
	No.	Mean			Tota	Unchanged	Changed		Total No.	Mean Depth	
Illinois	940	1884	1,224	51.7	925	426	499	2.80	1,224	25.6	1.077
Indiana	720	1887	939	53.5	657	291	366	2.89	939	26.7	1.256
Iowa	1,303	1887	1,527	84.4	1,160	632	528	3.61	1,502	46.1	1.570
Kentucky	579	1887	805	41.2	595	254	341	1.97	805	29.4	0.856
Michigan (lower)	843	1890	987	60.7	720	455	265	2.01	966	33.4	1.005
Michigan (upper)	72	1898	87	42.7	74	26	48	2.29	87	27.2	1.908
Minnesota	1,013	1896	1,158	76.5	920	404	516	3.45	1,132	42.8	2.464
Ohio	956	1880	1,243	44.9	908	425	483	2.41	1,243	24.8	0.800
Tennessee	518	1891	758	54.3	487	235	252	1.94	758	39.0	1.023
Wisconsin	672	1891	779	74.5	620	234	386	3.87	777	49.5	2.037
Aggregate	7,616		9,507		7,066	3,382	3,684		9,433		
Average		1888.3		61.3				2.85		35.1	1.315
Missouri	1,147	1888	1,527	58.7	1,048	710	338	0.95	1,520	33.6	0.432
Grand aggregate	8,763		11,034		8,114	4,092	4,022		10,953		

try available for water supply and navigation no less than power are interrelated through the ground-water reservoir in such wise that the regimen of each is dependent on the integrity of the ground reserve by which it is chiefly maintained. The essence of a stream resides in its continuity of flow; and this continuity of flow is in nature due absolutely and wholly to continuous supply from the store of ground-water.

12. Since the water vapor which bathes the continent and tempers its climate is not all precipitated on the land over which it passes, but in part goes on over adjacent seas; since the part precipitated as rain and snow and distilled as dew is largely re-evaporated from soil and open water, especially from growing plants whose vitality it sustains; since the residuum mainly soaks into the earth (and should do so wholly, in order to retain the best natural and artificial balance) where it forms a reserve store of ground water for a period averaging perhaps ten years; and since streams are fed chiefly—under the best conditions wholly—from this ground-water reserve, it follows that the fresh water of the country, as a whole, in its forms of vapor, rain, snow, dew, ground-water, lake and stream, is essentially a grand physical unit made up of interdependent parts, and that each stream, despite its essential unity and the interrelation of all its parts, is but an integer within the larger unit.

RELATIONS IN EQUITY

13. Water is the prime necessary of life. Fully five sixths of human food, and indeed a like proportion of the human body, consists of H_2O or water, chiefly in its simple form, partly in chemical combinations. In the human organism water is essential to assimilation, to metabolism or structural growth, to reproduction—indeed it would appear that no vital process occurs in the absence of water or otherwise than as a manifestation of its inherent properties. In the plants and lower animals yielding human food and clothing, water plays an equally essential rôle—indeed without water the continent would be unproductive and uninhabitable, and the lands of the planet but a dead world.

14. In this as in other countries, water is the primary natural resource. Industrial and other forms of activity on which rest the power and growth of peoples and states depend absolutely on the maintenance of human life and population, which in turn depend on food and measurably on apparel; and whatever its breadth in land and wealth in minerals, no continent can sustain human life and population without sufficient water for drink and for producing from the soil the materials for solid food and clothing. The average crop plant transpires 450 times the weight of its own (dry) substance in water during its growth; and reckoning evaporation from the soil of the moisture required to maintain proper texture, the agricultural duty of water is to produce one thousandth of its weight in average plant crop, or one four-thousandth in grain, or perhaps one forty-thousandth in meat.[5] Under rigid economy an adult human worker may be sustained for a year by 200 pounds each of bread and meat, with 2,000 pounds of water for drink; or, since the bread and meat require for their production respectively 400 tons and 4,000 tons of water, something over 4,400 tons of water in direct sustentation, apart from that required for ablution and for melioration of climate through aqueous vapor in the air.

[5] "The Agricultural Duty of Water," U. S. Department of Agriculture Yearbook for 1910, pp. 169–176.

Under irrigation, where alone agricultural water is measured, a five-acre farm supplied with 60 inches of water per year will sustain a family of five, including surplus produce for exchange; this is at the rate of five acre-feet (about 6,800 tons) per inhabitant—at which rate mainland United States might sustain permanently, with its 5,000,000,000 acre-feet of rainfall, a population of 1,000,000,000; the 2,000,000,000 acres of land would indeed support over 2,000,000,000 people if occupied to the density of Belgium (649 per square mile)—but neither land nor any other resource except water affords any measure whatever of the capacity of the country for production, population, power, or perpetuity.[6]

15. As the primary resource, water alone gives value not only to land (as is clearly realized in arid regions) but to all other resources. It is the ultimate basis of values, and can not equitably be regarded as an appurtenance to land or to any other subordinate resource, though in equity land and other resources may be—and in arid countries are commonly—considered practically appurtenant to the natural water.

16. As the prime necessary of life—the ultimate basis of existence for each of the individuals united in the nation—the water of the country is, under that leading principle of our national existence that all men are equally entitled to life, liberty and the pursuit of happiness, the common and indivisible possession of all—a possession in equity inalienable and indefeasible, since no constituent of the nation could alienate or divest himself of his share without surrendering his right to life and so weakening the nation.

17. As the common property and equitable possession of all, water in any form, together with the appurtenant lands or other resources, may be administered in the public interest by municipalities, states and the national government; but no public agency may in equity alienate, or divest the people of any part of the common interest in the water, nor may it equitably transfer any right to use of the water without just consideration in the public behalf. As the prime necessary of life and the primary resource, and as the common possession of all, water is in itself a special property, and its equitable administration is rightly the most sacred trust confided by the people in their chosen representatives and officers.

18. While the uses of water are diverse, they are not equally essential to life and to that general development of the country on which its power and perpetuity must rest. Since life can exist without it for but a few days, the primary use of water is for drink and other domestic supply, in which it is consumed; since continuous life can be sustained and the generations maintained only through food and clothing produced by its consumption, the secondary use is for agriculture, including irrigation; since the measure of industrial proficiency is the conquest and use of power, the next use of water in order of importance is for mechanical power, in which its substance (or corpus) is not consumed though its movement is utilized; and since the activities of commerce are necessarily subordinate to the primary industries, the least essential use of water is for navigation, in which it is not consumed and only its inert corpus is utilized. Yet the several uses may and should be combined, as when water for domestic supply or irrigation is used for power—and the development of power generally promotes navigation.

19. Since individuals are merged in various business and civic organizations

[6] "Prospective Population of the United States," SCIENCE, Vol. 34, 1911, pp. 428–435.

without loss or impairment of their individuality or their rights and duties as constituents of the nation; since the circulation of rain-yielding vapor is wholly independent of civil boundaries, while the movement of ground-water generally, and the courses of streams largely, are independent of such bounds; since water in artificial conduits and hydro-electric power are essentially commodities and the physical means of carrying them are frequently interstate; and since the chief uses of streams commonly vary in different parts of their courses and often in civil divisions, while the federal government alone can deal with interstate navigation and international waters, no municipality or state or federal agency can claim exclusive jurisdiction over water, or the exclusive right to administer it.

20. Since the chief purpose of statutes and common-law and courts is to prevent inequity, so that their nature is static and their effect generally prohibitive or restrictive or at most permissive, while the activity on which development depends is dynamic and constructive and in its essence progressive (wherefore it is not initiated but merely guided in direction by the static qualities of law and court), it follows that the inherently progressive development in the use of water attending the natural growth and orderly development of the people can best be fostered by combining individual and institutional agency in the highest practicable degree—*i. e.*, by effective cooperation among individuals and both business and civic organizations, including corporations, communities, municipalities, states and federal agencies.

LEGAL RELATIONS

21. Most legal relations affecting the uses of the water of the country are prohibitive or restrictive, or otherwise negative in character; comparatively few thus far developed are positive and constructive.[7]

22. Constructive development of the legal relations of water in eastern United States began with Chief Justice Marshall's interpretations of the commerce clause of the Constitution, largely in McCullough *v.* Maryland (4 Wheaton, 316–437) and more specifically in Gibbons *v.* Ogden (9 Wheaton, 1–240), which established federal authority over navigable streams and navigation; and the next noteworthy constructive step was taken by Chief Justice Taney when he cut loose from the English definition of navigability, showed that English standards are wholly inapplicable to this country, and established the principle that the question of navigability is

[7] Normal development of appreciation and equitable use of water in this country was unfortunately retarded through decisions and sometimes through statutes and state constitutions applying (without shadow of constitutional warrant) principles arising in the English common law, under which water is virtually held a mere appurtenance to land—a usage arising in a small and well-watered but nearly riverless island, and not only illogical in itself (in the impossible condition that a user may remove water from a stream provided he does not impair the flow), but wholly inapplicable to a great continent containing large rivers, though insufficiently watered as a whole. Better standards would doubtless have arisen through importation of the French-Roman law (through the Code Napoleon), under which the water may be said to pertain to the community, save that it was practically limited to the over-watered state of Louisiana; and still better standards were actually introduced into the arid region in the Spanish-Roman law, under which water is allotted by prior claim and continued beneficial use and the land is virtually appurtenant thereto, though this equitable principle has been gradually outweighed by the force of the non-equitable English common law brought in from more populous sections.

one of fact (the Genesee Chief *v.* Fitzhugh, 12 Howard, 443, *et seq.*, especially 456–7) —a principle ever since recognized in this country, save as laxity in federal administration and zeal in state aggrandization have permitted insidious invasion of navigable and necessary source streams by devices for other uses of the water. The third step in the same line (with which advance practically terminates) was marked by the Supreme Court decision in the Rio Grande case establishing the power of the federal government to protect the source streams on which depend the navigability of the lower waters (United States *v.* Rio Grande Dam and Irrigation Company, 174 U. S., 690–710)—the oft-quoted Kansas-Colorado case, though conformable, being virtually a nonsuit and of little bearing on principles affecting the general relations of water.

23. The most significant advance in the development of legal relations affecting the primary use of water in this country was made in a decision of the New Jersey Court of Errors and Appeals, subsequently affirmed by the U. S. Supreme Court, that the people of the state collectively have a residuary right in the intrastate waters (Hudson Water Company *v.* McCarter, 209 U. S., 349–358), a manifestly valid doctrine which requires nothing but application in other states with respect to their intrastate waters, and extension to the concomitant federal authority over interstate waters in their nature as navigable streams or as sources of such streams, to work a great public benefit. A development of the same equitable principle appears in an opinion of the Supreme Court of Maine that the legislature may prescribe such control of private property in woodlands as may be required to protect public interests in the permanent water supply conserved by the forests; while the Oregon water law of 1909 by clear implication and the California water law of 1911 in specific terms declare that the waters of the state belong to the people of the state.[8]

24. During recent years the Congress has enacted various constructive laws conformable with and even extending the principles so established by the United States and state courts. The most conspicuous of these is that providing for the reclamation of arid districts by expending certain proceeds of public land sales in diverting water from its natural channels to irrigate dry tracts, thereby promoting the public welfare (conformably with the "General Welfare" clause of the Constitution) through a virtual extension of the public domain in substantial accord with the principle of the Spanish-Roman law under which other resources are essentially appurtenant to water. A related principle was applied in the creation and maintenance, through administrative and legislative action, of national forests designed not only to protect timber but to conserve the water of source streams; and it was definitely established as a national policy within a year by an act providing for the purchase of lands in the Appalachian and White Mountains for the specific purpose of conserving source waters, primarily and ostensibly to protect navigation in the lower rivers—though it was well understood in the deliberations attending the enactment that incidental effects of even greater public benefit would arise

[8] Some state constitutions, as in Colorado, provide that waters within the state belong to the state, thereby setting up a claim to interstate waters bound to eventuate in expensive and fruitless litigation unless the claims are composed by equitable cooperation and sharing of natural and legal rights and duties between the states and the federal government.

from protection of the streams in their middle courses where they may be used for power development without impairment—indeed with promotion[9]—of navigability below, and from the general conservation of the natural water for all other uses (in fact it would appear that this act was passed in direct response to a popular demand based on manifest equities and recognition of the public good rather than on any narrow construction of common-law or statutes or decisions).

25. Sundry enactments by the congress during recent decades serve to establish what may be considered an inchoate national policy touching the development of water-power on navigable streams whereby, (1) when a franchise is given a private corporation to erect dams the federal government reserves the right to use without charge so much of the power developed as may be required for specific purposes, a reservation which may be deemed in the nature of consideration (and recently this was extended by making the consideration specific and limiting the term of the franchise); (2) when works are constructed cooperatively between the federal government and prospective power users the government reserves rights of administration and for specific uses, and also limits the tenure of the lease or franchise to a specified period; and (3) when the dam is constructed at federal cost the leasing of power developed thereby is authorized under conventional restrictions as to advertising, etc.[10] The policy so initiated is not only naturally susceptible of extension with growing knowledge concerning

[9] Not only does each open reservoir for power development hold back the flow of the stream and so shorten the low-water season, but each serves to saturate the adjacent soil and subsoil and rock with an additional volume of water subserving the same end—a volume often comparable with that of the pond itself.

[10] The first case is covered by the provision of the general "Act to regulate the construction of dams across navigable waters" (1906) to the effect that "The person owning such dam . . . shall grant to the United States a free use of water-power for building and operating" any constructions which may at any time be required "in the interest of navigation" (U. S. Stat. at L., Vol. 34, p. 386); and this provision is reaffirmed in special laws of various dates. The second case is exemplified by "An Act to enable the Secretary of War to permit the erection of a lock and dam in aid of navigation in the Tennessee River near Chattanooga, Tennessee, and for other purposes" (U. S. Stat. at L., Vol. 33, p. 309), in which it is provided in Section 4 "That in consideration of the construction of said lock and dam, free of cost to the United States . . . the United States hereby grants . . . such rights as it possesses to use the water-power produced by said dam, and to convert the same into electric power or otherwise utilize it for a period of ninety-nine years: *Provided,* that it or they [the grantees] shall furnish the necessary electric current while its or their power plant is in operation to move the gates and operate the locks and to light the United States buildings and grounds, free of cost to the United States: *And provided further,* . . . That the Secretary of War is hereby authorized to prescribe regulations to govern the use of the said water-power and the operations of the plant and force employed in connection therewith." The third case is covered in the provision of the River and Harbor Act approved June 13, 1902 (U. S. Stat. at L., Vol. 32, p. 358), under the item for "Improving Cumberland River, Tennessee, above Nashville," as follows: "And the Secretary of War is hereby authorized, in his discretion, to grant leases or licenses to the highest responsible bidder for the use of the water-power created by said dam, at such rate and on such conditions and for such periods of time as may seem to him expedient . . .: *Provided,* that any lease or license so granted shall be limited to the use of the surplus water not required for navigation . . .: *Provided further,* that before leasing or licensing such water privileges, or issuing permits for the construction and operation of such canals, or otherwise disposing of any water-power or privilege, the Secretary of War shall first advertise the same in one or more daily papers at Nashville, for sixty days immediately preceding, stating specifically the right or

physical relations and the increasing value of power attending the natural growth and orderly development of population and industries, but clearly requires such extension in the interest of general welfare.

26. Federal legislation touching river and harbor improvements has commonly been kept well within the principles laid down by Marshall and Taney, has apparently disregarded the vital principle established in the Rio Grande case, and has shown little progress in the development of standards and ideals conformably to the needs of a great and growing country either for improved transportation or for better use of streams; yet a notable advance has arisen in connection with the work of the Mississippi River Commission which, in cooperation with state officials in Mississippi, Louisiana, and perhaps other states, has extended its work from merely perfunctory revetment of banks for improving navigability in the lower Mississippi to design and location of revetments in coordination with the state work for protecting adjacent lowlands, and has even aided in levee construction—thereby establishing (1) the principle of cooperation between state and federal agencies, and (2) a recognized duty on the part of the federal government so to control regimen in navigable streams as to protect adjacent lands.

27. Repeated enactments by the federal congress in conformity with the work and reports of the administrative departments seem to have established at least in inchoate form a duty of the federal government to take measures looking to the control of all the waters of the country in the public interest: In the War Department the physics and hydraulics of the Mississippi were investigated with a view to control of the river; in the War Department and later in the Department of Agriculture rainfall was measured with reference to drainage basins and stream floods, while of late floods are gaged and flood warnings are issued for the public benefit; in the Interior Department the hydrographic branch of the Geological Survey is gaging all the streams of the country and determining their regimen (including the amount of sediment in the water) with a view to more complete control, the work being sometimes done in cooperation with states; in the same department the operations of the Reclamation Service in diverting streams for irrigation, generally in cooperation with individuals and states, are carried forward vigorously; in several bureaus of the Department of Agriculture investigations and measurements of water are conducted with respect to irrigation, drainage, soil-plant circulation, destructive erosion, etc.—indeed it may be said that the function of the department in dealing

privileges proposed to be leased or conveyed, with its exact limitations, inviting bids for the same, and he may, in his discretion, then lease the same for a specific term of years at so much per year, to be paid semi-annually in cash into the Treasury, and the Secretary of War shall reserve the right to reject any or all bids.'' The extension in the first case is covered in the amended general dam act approved June 23, 1910, by the provisos ''That . . . the Chief of Engineers and the Secretary of War shall consider the bearing of said structure upon a comprehensive plan for the improvement of the waterway over which it is to be constructed with a view to the promotion of its navigable quality and for the full development of water-power; and . . . shall provide for improving and developing navigation, and fix such charge or charges for the privilege granted as may be sufficient to restore conditions with respect to navigability as existing at the time such privilege be granted''; and ''That the authority granted under or in pursuance of the provisions of this Act shall terminate at the end of a period not to exceed fifty years from the date of the original approval of the project.''

with water and its derivatives—all looking toward increasingly complete control and utilization for the public benefit, while largely in cooperation with individuals and state institutions, the growing knowledge is applied and the control extended from year to year in increasing degree; in the Department of Commerce and Labor the bureau of corporations has made a systematic investigation of navigation with a view to better regulation of both natural and artificial facilities; and in the same department the census bureau has reckoned the actual control of water for irrigation. Under the federal legislation and administrative operations, water is not only measured more accurately than in any other country but is steadily passing under control in the public interest, largely through cooperation with individuals and states, yet always in such wise as to exemplify and establish the common interest of all the people in the water of the country. The advance in this direction during the last decade has been especially rapid; and though apparently little noted, it is among the most significant in our entire history with respect to knowledge, use and administration of the natural waters.

28. Especially in connection with municipalities, a usage has arisen with growing necessities which is congruous with current legal practise in detail, although incongruous with the foreign legal notion that water is a mere appurtenance to land: in all leading cities adequate water supply is provided substantially at public cost, and such lands as may be required to accommodate mains and reservoirs or other works are acquired for the purpose by condemnation or otherwise, while in many cities the lands required for catchment areas are either condemned or purchased, or else arbitrarily protected from contamination—all in accord with the principle of the greatest good to the greatest number; in some cities (notably Los Angeles) the income from power developed by the head of the water is, or is to be, applied in liquidating the cost of both waterworks and land; some municipalities (again notably Los Angeles) allot the surplus water to irrigation for the common benefit, while in many towns and cities the surplus is used in sewerage systems sometimes designed to repay costs through useful disposition of the sewage. The several cases mark growing recognition of the fundamental fact that water is the prime necessary of life and the primary resource, and serve to establish, at least in inchoate form, the doctrine that as population grows dense in relation to the quantity of water, land necessarily becomes a mere appurtenance to that resource on which the lives of the people depend.

29. Under the generally progressive development of legal relations throughout our history, a foundation has been established not only in equity but in law for constructive action by state and federal legislatures, and for judicial decisions more in accord with current knowledge and existing conditions than with archaic standards developed in other countries of different conditions.

30. The essential principle of natural equity on which specific legislation may rest has already found expression, both by statesmen and by powerful associations of citizens including both jurists and publicists, in the incontrovertible proposition —now become axiomatic—that *all the water belongs to all the people.*

PROPOSED APPLICATION OF PRINCIPLES

31. Any action looking toward better utilization and development of the water of the country must be influenced by the

magnitude of the values involved. Since water is the sole source of productivity and habitability, it is the primary basis of all values; and since the property of the country may be appraised at a figure approaching $150,000,000,000, while the water reserve (stored chiefly in the ground) may be estimated at ten years' rainfall or 50,000,000,000 acre-feet, the one may be balanced against the other as the gold reserve is balanced against the currency whose circulation maintains property values. Reckoned in this way the value of the water reserve may be put at $150,000,000,000 in gross, *i. e.*, $3 per acre-foot or 2.2 mills per ton—a reasonable figure, corresponding fairly with the current cost of irrigation water, and far less than any current water rates in cities or even the ordinary margin of rates above the cost of waterworks. In connection with the gross valuation, it may be noted (chiefly on the basis of estimates by the National Conservation Commission toward the end of 1908) that more than 10,000,000 of our people are supplied—largely from protected catchment areas of over 1,000,000 acres—by waterworks, which for 42 cities (not including Chicago, Philadelphia, Cleveland, Cincinnati, *et al.*) cost no less than $271,159,483 and perhaps as much more for catchment basins, and supply 1,324,300 acre-feet of domestic water,[11] worth in round figures computed at $3 per acre-foot $4,000,000 annually; that some $200,000,000 are invested in irrigation works, using 34,000,000 acre-feet of water annually to render productive 13,000,000 acres of arid lands; that the water-power available at a cost comparable with that of steam installation is 37,500,000 horsepower (enough to "operate every mill, drive every spindle, propel every train and boat, and light every city, town and village in the country"[12]), worth in gross earning power $20 per horsepower-year or $750,000,000 annually; that the annual loss through draining away of the ground water in only nine interior states, reckoned at $3 per acre-foot, is $442,000,000; that the estimated yearly loss through soil erosion is $500,000,000; that if navigation were so developed that one fifth of our freight moved by water the annual saving to producers and consumers would be $250,000,000; and that needed drainage of our 75,000,000 acres of swamp and overflow land would add over $20 per acre above the cost of draining (or $1,500,000,000), to our national wealth and provide home-sites for 5,000,000 to 7,500,000 families. Even the most conservative figures indicate that the development, control and utilization of water raises the largest and one of the most pressing economic issues now before the American people.

32. Since the uses of water are interdependent and most of the physical relations interstate, complete control may not be exercised justly either by any single state sovereignty or by exclusive federal sovereignty; so that concurrent legislative and administrative action is required by states and the municipalities within them and by the federal government.

33. Since under the Constitution the federal government is primarily responsible for the general welfare, requisite action may properly, and in view of the urgent demand should without needless delay, be initiated by the congress.

34. The magnitude and complexity of the interests affected, the delicacy of the legal relations involved, and the dearth of both exact knowledge and practical experience concerning the several uses of

[11] Report of the National Conservation Commission (60th Congress, 2d Session, Senate Document 676), 1909, Vol. II., p. 178.

[12] *Ibid.*, Vol. I., p. 41.

water, all indicate that action taken at this juncture should be constructive and developmental rather than definitive. While the relations in equity seem clear, and while the legal relations appear to form a firm foundation for a broader legal structure than has hitherto been attempted, the technical experience needed to guide definitive legislation remains inadequate: it is barely over a decade since electric power transmission began reconstructing industries, since the internal-combustion engine began closing the age of steam (which may reopen under the steam-turbine), since steel-concrete construction began revolutionizing the use of resources, since irrigation began opening a new era in standards of production; and the concepts of even the most advanced jurists and law-makers can hardly be quite abreast with, much less far in advance of, the technical experience attending these industrial developments. Moreover, the concept of water as a common possession in equity of all the people remains novel in many minds, and is bound to result in new and unforseeable interrelations among individuals and civic organizations, and especially between states and the federal government—interrelations that can be adjusted and regulated in the common welfare only as common experience grows with advancing applications of increasing knowledge. It would no more be practicable to establish definitive regulations for the use of the natural waters to-day than it would have been to create our magnificent railway system by fiat 80 years ago, to establish our intricate banking system when the Constitution was framed, or to found by a stroke of the pen 20 years ago the Department of Agriculture with its hundreds of scientific experts, made such by long-continued training. The need for action presses; but wise action to-day can be no more than preparatory for, and directive of, prospective and inevitable development.

35. In view of the interstate relations of our natural waters, action by the congress should be framed with special reference to that comity with and among the states best maintained by sharing, rather than by disputing as of old, common interests—a course in which useful experience has been gained in the Mississippi River Commission and Reclamation Service, as also in the Forest Service and other leading bureaus of the Department of Agriculture; and the federal legislation should not merely form a model for states, but should authorize necessary administrative action directly and in conjunction with states.

36. Since practical experience is a *sine qua non* for wise legislation, early state and federal enactments should be framed in general terms, entrusting the actual work to administrative agencies under proper restrictions and provisions for reporting progress to the legislative authority, much as in the statutory authority for state and federal departments.

37. While the magnitude and importance of the issue involved in control and utilization of water would warrant the creation of a federal department to meet it, such action at this juncture might be premature—especially since the more pressing requirements may be met through existing departmental facilities. The several considerations point toward a presumptively temporary federal administrative agency, created or empowered to make investigations and take action looking toward the progressive control and regulation of the water of the country with respect to all uses, both directly and in cooperation with states and when needful with individuals,

corporations, communities and municipalities—such agency to report through the executive annually and at such other times and in such modes as the congress may require. It should be among the first duties of the federal agency to confer with officers or other competent representatives of states concerning water-power and other uses of water with a view to determining means of effective cooperation, equitable sharing of rights and responsibilities, estimates of cost of works required for state and federal use, reasonable rates for domestic and irrigation water supply and for power, and all other matters of common concern to the state and federal governments—the determinations to be reported to the state legislatures and to the congress as a basis for further action in the public interest in accordance with the righteous principles of the greatest good to the greatest number for the longest time.

38. While it is not necessary and might be inexpedient for current federal legislation to specifically declare the principle that all the water of the country belongs to all the people of the country, the enactments may not equitably, nor judiciously in view of the trend of that public sentiment in which lies the power of the nation, be open to construction as dissenting from or denying that principle; for already this has become part of the body of ethical conviction underlying American character and constituting its strength.

W J McGEE

UNIVERSITY EXTENSION AND THE STATE UNIVERSITY[1]

THE state university is a public service corporation. It is supported by the public presumably *for* the public. Until within comparatively recent years, few questions have been asked as to the quality and comprehensiveness of the service offered by the university to this constituency, but the time has arrived when not only educators, but intelligent laymen, including both employer and employed, are asking to what degree the relation of the people as a whole to the educational system has been recognized.

What proportion of the young folk who become high school students are served in future years by the university? What proportion of those who remain in school for elementary training only, reap more than the most meager benefits from our so-called popular education?

The high average percentage of illiteracy in the United States, the low comparative degree of efficiency in the industries and the avidity with which opportunities for further training are embraced by persons who have completed their formal education, all point to a fault in the existing system, for which there is at present no generally adopted remedy.

It is not my purpose to dwell upon the shortcomings of our public education, nor to enlarge upon the fact that statistics relating to school attendance would give less cause for discouragement if we recognized in our public schools the value of training for efficiency. A radical change in the curriculum, aimed at retaining the interest of the pupil by showing him the value of his education as a usable asset, would tend to lengthen the term of school life for both boys and girls and, in many cases, would prolong it into and through the university.

In view of this lack of what may be called vocational applications in school training, it is not difficult to understand the reason for the almost overwhelming demand from persons engaged in business pursuits for an opportunity to enter, how-

[1] Presented before Section L, American Association for the Advancement of Science, at the Minneapolis meeting.

ever late in life, upon serviceable courses of study.

It is a question upon which opinions differ, whether or not the university is the source from which extension teaching in its present development should emanate, but so long as there is no other agency prepared to do the work, the question admits of an affirmative answer only.

There is much to be said in favor of a policy which associates with the university the work of extending educational advantages to the people in their homes and places of employment. A measure presenting such immense possibilities of usefulness to the whole people, would seem to belong as an organic part to the state educational work. In order to secure permanence of establishment and growth, extension teaching must be given assured and liberal support, and for reasons of economy and convenience its central offices should be placed where the resources of the great head of the state system would be available for its use. The value of this association has been demonstrated in the success of agricultural extension, which could not have flourished apart from the agricultural college, whose instructional force, facilities for research and material equipment have been essential to its usefulness.

Although close affiliation with the residence work of the university is important, this does not imply that extension instruction shall be limited to courses of study of university grade, nor even that it shall conform necessarily to any conventional schedule of studies. The range of extension activities includes not only such courses as entitle the student to credit toward university or advanced degree, school teacher's diploma or other certified recognition, but also short courses and conferences not leading to a degree, and the promotion of a great variety of interests that reach the people, both young and old, in the intimate relations of their daily life.

In this breadth of scope is seen the vital spirit that animates the new conception of university extension—the spirit of boundless liberality, which would make useful to the entire people, in whatever place, in whatever walk of life, that great fund of knowledge which accumulates and is available at a university, be it the product of research, scholarship or of great gifts of mind and heart.

Having conceded the point that the state university is the natural and proper guardian of the educational interests of the whole people of the state, existing under an obligation to those who can not enter her walls similar to that she owes to her resident student body, we are confronted by the paramount question of method by which every part of the state shall be reached by the university without duplication of machinery, yet effectively and thoroughly. In order to solve this problem of covering the field without waste of effort, it is probable that no method can be absolutely successful which does not involve division of the state into districts having local headquarters, from each of which the various activities of extension shall be promoted within the limits of its territory. The organization may then be compared to a great wheel of which the hub is the university, the rim the boundaries of the state, and the spokes the lines which divide the whole into districts. At the hub, or central headquarters, will be located the dean or director, the several secretaries of departments and the specialists who offer lecture courses, prepare correspondence-study lessons, publish bulletins designed to aid the student in the study of topics for debate, or gather, classify and hold ready for the applicant, instructive literature on a wide range of subjects useful to the stu-

dent as a private individual or as a citizen of state or municipality.

At the district headquarters will be placed a superintendent, field organizers and local teachers. The working plant will include, in addition to offices for administrative purposes, class rooms, laboratories and library facilities, conveniently situated for the use of groups of students.

The problem of finding a staff of extension workers possessing the very special qualifications required of them is a serious one, but extension teaching is itself assisting in the preparation of suitable men and women to carry on its work, and furthermore, with the introduction of new methods, extension has ceased to depend solely upon a staff of lecturers who must combine the qualities of public speaker, scholar and philanthropist. An organization similar to that outlined in the foregoing pages, so differentiates and distributes the work that there is no longer the necessity, as in the older forms of university extension, to find men who unite in their individual persons a large number of qualifications. Nevertheless, it must be recognized that certain qualities in the extension worker are of essential importance. The district representative, for instance, must be selected with the most painstaking care, and must combine the tastes and training of a social worker with business acumen, and acceptable personality. His training should have been sufficiently liberal to enable him to understand conditions in his community as they are affected by business relations. If the leading industry of his district is agricultural, he should possess some knowledge of agricultural interests; if manufacturing, he should be more or less of an engineer; if commercial, he should be acquainted with commercial processes. He is the representative for his district of all the specialists of the university, and the knowledge required of him is such as will enable him to place at the service of the people with whom he is related the resources of the state educational center.

Thus far, little has been said of the actual processes of instruction to be carried on by means of the machinery so fully described. Correspondence-study, debating and informal discussion, lecture, information and welfare service may be included in its scope.

It will not be possible in the short time that should be consumed by this paper to enter fully into description or even enumeration of the activities through which the university may serve individuals or communities in all parts of the state.

Detailed description of correspondence-study teaching may be omitted. Its processes are well known and for many years were discredited. At present, it is coming to be accepted as a valuable educational method. In conjunction with weekly or bi-weekly classes, in which the student is brought into personal touch with the instructor, it serves usefully in teaching the industrial employee, whose conditions of life and training as a rule are not favorable to close or unassisted application. While with the trained student, experience goes to prove that correspondence-study may present decided advantages. The testimony of several teachers in The University of Wisconsin, where skepticism prevailed a few years ago, may be of general interest in this connection.

From the head of the department of German in the university:

> We have given correspondence courses in almost all branches of the work of the German department—in grammar, reading, composition, literature, philology and methods of teaching—and these courses when pursued by students of adequate general preparation and maturity have regularly yielded very valuable results in the imparting of both training and knowledge.

I entirely share the opinion of Professor Prokosch, who has carefully watched the results of the work, that former correspondence students entering our university classes have proved that they had derived a full measure of benefit from their work. I may add, however, that I believe such satisfactory results are only where, as at the university, in our case, there is close and harmonious cooperation between the general management of the correspondence work, the instructor actually doing the work, and the regular University department in which the work falls.

From an associate professor of history:

The lesson papers of almost all of my pupils have been of good quality, evincing painstaking and thoroughgoing study and power in the subject. The results of the final examinations have been uniformly good. The three correspondence subjects in which I have had most pupils have been Greek history, medieval history and English history.

At the same time that I have been conducting this history study by correspondence, I have been having quiz sections in these same subjects with pupils in attendance at the university. It is natural that I compare the performance of these two sets of pupils. The requirement made of correspondence pupils was as great as of the residence pupils. The text-books were the same, and the ground covered in each subject was the same for each set. The results obtained from the best of the pupils in correspondence work were fully as good as those from the best in residence work, and the average quality of the correspondence work was superior to the average quality of the work done in residence. This last fact is doubtless due to this, that in a large degree these pupils are a naturally selected group. It is well enough recognized that the thirst for knowledge is by no means the only motive that induces a student to enter college, or to continue there. It is, however, the principal motive that prompts the correspondence pupil to undertake the work and this makes and keeps him very responsive to the teacher's efforts.

A correspondence instructor in Latin says:

I have discovered that the students do more work in these Latin courses than they do in the same work as resident students, a fact that the head of the Latin department in the university has found out recently quite apart from my own discovery.

An instructor in the English department, who also has experience in both university and correspondence work, says:

The student in correspondence work has far more individual teaching than is possible in classroom work, and he comes into closer touch with his instructor, who knows his environment, his ambition and his special needs, and is therefore interested to teach him—not only as a student in general, but as an individual in particular. It is a fair statement that I am in closer touch with each of my correspondence students than I could be with one tenth of them in residence, and I have had many pleasant letters expressing delight that this condition really exists.

You may remember that I rather regretted giving up my teaching to work in the extension division, because I believed so firmly in the value of individual instruction. One of the pleasant surprises in my correspondence work has been the opportunity to continue to do individual teaching.

Unquestionably, the correspondence student loses that intangible something we hear so much about, which university life gives and which many value highly. On the other hand, his work receives closer supervision than that of the resident student and his relations with his teacher, as shown by the letters quoted, are more intimate, though of a different character. The student who takes work by correspondence is usually mature. In residence, he would belong to that class of university student which does not identify itself with many of the ordinary student activities. Consequently, he does not lose so much by doing his work away from the university, and it should not be forgotten that those who take part of their work by correspondence are usually persons who, were it not for this opportunity, would never enter the university at all.

Correspondence study, for purposes of university extension, must include courses of practically every grade. The teaching force must be selected with special reference to the peculiar relations between

teacher and student. The residence instructor is frequently not well adapted to this work. I fully agree, however, with the head of the German department, whose views I have quoted, that the work for credit must be under the careful supervision of the residence departments, since they are responsible to the university for the maintenance of a standard. The work of applicants for degrees, non-resident or resident, must, of course, conform equally to this standard.

Department supervision is, in general, not necessary for the vocational courses, and is not as a rule desirable. There is danger that the influence of the old academic spirit may operate to make vocational correspondence study as applied to industrial workers ineffective and practically valueless. Professional men, including lawyers, physicians, clergymen, teachers and the like, will, naturally, select courses of study that are closely related to the resident work. But a different treatment is required for students of the industrial class who, though mature in years, are immature in mental processes. Many of these have no fixed habits of study, or are unaccustomed to confinement out of working hours, and frequently realize only imperfectly the benefits to be derived from a course of study applied to their vocation. They are often burdened by home cares. The fact that the fee, however small, would help to lighten the home burdens will often affect their judgment, and the present is more significant to them than the future. These students need constant encouragement with close personal contact. They must be shown in the class room, in the shop, or the local laboratory the application of their instruction to the industry in which they are employed. An occasional meeting in the class room under the direction of an instructor, where notes and experiences in the work can be compared, acts as a helpful stimulus.

The method of instruction which combines correspondence study with class work, applied under the conditions of such district organization as has been described, has been successfully applied. In mining districts classes of industrial workers engage under local direction in courses of study designed to improve their proficiency in mining engineering; in manufacturing districts, shop mathematics, machine construction and other subjects fundamental to mechanical processes are studied; in commercial centers, business courses; in rural districts, agricultural subjects; in fact, university extension effectively administered through district organization should offer vocational training in every part of the state directly applicable to the prevalent conditions.

An interesting and valuable phase of extension work has to do with choice of occupation. The Vocational Bureau in Massachusetts has demonstrated that a large field of usefulness is open to the instrumentality that has for its object guidance of the individual, whether young or old, toward the selection of an occupation adapted to his abilities and tastes. Many a man is a failure because he is in the wrong place. The bootblack who is shown the way to fit himself for more remunerative and agreeable work, the clerk who is helped to achieve the broader usefulness for which he has ambition and capacity, in a word, every misfit who is assisted to discover and develop his peculiar abilities becomes a more valuable unit to himself and his community. It is evident that district organization may be a useful agent in bringing the needed opportunity to persons whose latent possibilities are worthy of recognition and development.

Other activities of the district force will

include the introduction of lecture courses; the organization of debating or other clubs; the formation of night classes; the spread of library facilities; the opening of laboratories; the promotion of educational measures in business organizations; the assistance of town or rural communities in civic or social improvement; the conduct of institutes or conferences—the number of these activities is too great for enumeration. The district representative's acquaintance with the people and the organizations in his district, having for their object industrial, social or civic betterment, will enable him to place the university at their service.

An important possibility for extension activity is that which would bring the work of the great research departments of the nation, the state and the university within the grasp of the people to whom their results would be valuable, if spread abroad in terms suited to the layman's comprehension.

Scores of men are at work for the state, and for the nation, solving problems affecting industrial and commercial conditions, whose results never reach the people at large, or do so after costly delays. Much of this information is gathered at a cost of millions of dollars and would be of incalculable value if properly disseminated. It is not sufficient to determine in the laboratory that coal should be purchased on the basis of number of heat units in a pound, other things being equal, but this fact must be made known to coal users or buyers if it is to be of real value. Results obtained by experts and specialists to be of general use must be put into simple and direct form and brought to the knowledge of the people.

The need of the general public for non-partisan and dispassionate information upon the live problems of the day, political and other; the want in many places of library facilities for the study of such questions, or in the presence of the library, the lack of knowledge of its contents and how to use them; also the demand from schools for aid in arousing the interest of growing boys and girls in the issues that are before the country, all point to a fruitful field of university service. The policy is surely questionable, at least, which leaves to the press and political orators the education of the public in matters so essential to its welfare, as, for example, election of senators by popular vote, good roads, the wheel tax, commission form of city government, the recall, etc.

Existing organizations, of which there are many—such as civic clubs, women's clubs, business men's clubs, commercial clubs, debating clubs, etc.—and groups of people needing only a suggestion to lead them to form themselves into bodies for study and discussion, are anxious to consider the newer questions of the day, but often do not know where to turn for advice and assistance. There should be available at the university for the use of these organizations, collections of classified reference material in the shape of newspaper and magazine articles, books, and state and national publications relating to those subjects, to be lent under definite regulations free of cost.

There should also be published and distributed bulletins formulating subjects for debate and containing full lists of references, negative and affirmative, with information as to where and how they may be obtained. State traveling library commissions should cooperate in the work. In fact, as traveling libraries have such an important relation to all university extension work, it is a question whether the traveling library commission should not have an organic relation with university extension.

Topical package libraries, adapted to

high-school work in preparation of graduation themes and debates may be used to awaken interest among boys and girls in current questions. It will be found that high-school teachers are glad to divert their students from the old stereotyped subjects to live modern ones, when it is not too difficult to obtain reliable and timely information.

The wisdom of the establishment of a municipal reference bureau as a university charge will not be questioned when it is remembered that in a little over one hundred years urban population in the United States has increased from two per cent. of the total population to nearly fifty per cent. So rapid a growth as this must tax the powers of the legislator to the utmost, and is sure to be accompanied by an amount of groping in the dark and experimentation that may be disastrous. Large cities can well afford to establish bureaus of their own, manned with experts in municipal government, but such a course is absolutely impossible for the smaller municipalities and rural districts.

There is a general awakening to the need for better urban government, and recognition that this country is far behind many foreign countries in city administration. But it is seldom that the council of a town or small city will take the trouble to gain or even feels the need for information regarding practises and results in other places.

A university offers exceptional facilities for carrying on this work. Ordinances collected and filed for reference, together with data relating to their effectiveness as working measures, will be conveniently available through extension division channels. And the same instrumentality will connect the municipality with the service in a purely advisory capacity of the university specialist in such departments as sanitation, hygiene, street lighting or paving, and all matters affecting the general welfare of the people.

Frequently, in great movements, much effort is wasted in the creation of interest and enthusiasm, which is not sustained because no agent is at hand to keep the impulse alive until it is crystallized into permanent form. The crusade against tuberculosis, the schoolhouse social center movement, and many other similar undertakings of vital and far-reaching effect upon large numbers, would be much more surely advanced if controlled by such organization as belongs to university extension, than is possible under the ordinary conditions of inertia or spasmodic attack, which characterize the average community.

The experiment of cooperation between the Anti-tuberculosis Association and the university has been tried with marked success, and the social center movement is also recognized as a suitable work for university promotion.

The bringing together in united interests of groups, diversified in racial, political, religious and social affiliations is a step tending toward a more genuine democratization of the American people than has yet been experienced in their life or their institutions. The use of the schoolhouse out of school hours and of the public playgrounds for the work and play of people of all ages appeals strongly to the wide-awake educator as an economical, sane and healthful measure, one that provides a remedy for evils that exist both in urban and rural communities. As an educational means, it probably needs, for the present at least, the fostering care of a strong organization, quite as much as any other field of extension endeavor. University extension should find in this civic and social center a suitable vehicle for its operations.

The machinery of university extension

may legitimately be used in conducting conferences of interest to certain classes of workers. These may include conventions covering several days, or institutes of several weeks' or months' duration. An organization having the resources of the university at its command can easily assemble specialists in some given subject as, for example, civic and social service, criminology or the scientific aspects of a craft. Lectures, demonstrations and informal discussions are directed toward plain and lucid exposition of the problems under consideration. Authorities, not only from the university, but from over the whole country may be drawn upon for these conferences, with the result that the work will be up-to-date, scientific, practical and comprehensive in its applications.

One of the most widely known and gifted extension lecturers in our country wrote a year or two ago of the university extension movement:

> Like all ideas and movements, it has fulfilled itself in unseen ways. It is no longer an occasional and accidental phase of university work; it is an organic part of it. It is no longer concerned merely or primarily with short lecture courses, for without neglecting the lecture work that appeals to general audiences, it aims to reach, like any other part of the university, a student body . . . the very large body of partial or non-resident students.

Examination into the status of extension teaching in the United States discloses a remarkable broadening and liberalizing of the academic spirit. The fact that a number of the old conservative universities now offer extra-mural teaching with no more stringent specifications than that the applicant shall be able to show that he can take the work to advantage, is evidence of a notable change in their educational atmosphere.

The uniting of the eight leading educational institutions in and around Boston, including Harvard, Tufts, the Massachusetts Institute of Technology and others, into a Commission on Extension Teaching, denoted a striking departure from the old conception of higher education. The fact that these institutions have agreed upon a course of instruction leading to the degree A.A. (associate in arts) with no entrance examination or resident work requirements, is evidence of a radical readjustment of viewpoint among educators.

The cost of extension teaching, state-wide in its application, must necessarily seem formidable, but it must be recognized that not only does the system promise a degree of amelioration of economic and other conditions, but gives immediate and substantial returns in increased productive power of the trained over the untrained worker.

In 1907–08, according to the Commissioner of Education, the sum of $66,790,924 was spent in giving higher education in the United States to 265,966 persons. In the state of Minnesota $1,880,568 were spent in the same year for the education of 6,743 persons. No one acquainted with the facts will question the wisdom of this expenditure. Educated leadership is essential; the results of research as conducted in institutions of higher learning are far reaching, the value incalculable. Yet, if the state university is in truth a public service corporation, is not the public justified in demanding that this great expenditure be made to serve the entire state as its student body? Nor should the fact be overlooked that the extra-mural activities of university extension create an attitude in the people of the state, that will not fail to be reflected in greater loyalty and more generous financial support—conditions that may be counted upon not only to insure the spread of university benefactions, but to more rapidly advance the interests of the

conventional and long-established forms of higher educational work.

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AN OPPORTUNITY FOR THE SPIRIT OF RESEARCH IN LABORATORY INSTRUCTION IN PHYSICS

A RITUAL does not require worship; a system in laboratory instruction does not demand the investment of the personality of the instructor. A smoothly operating system is a delight to the mill owner or to the manufacturer. According to general practise, such a system affords the modern laboratory instructor in physics a great deal of satisfaction.

But has not laboratory instruction in physics become enslaved to laboratory methods? The fundamental purpose of such instruction should be decided in the light of its origin. At first the laboratory work was not prescribed in the course of study. Magnus[1] in Berlin conducted such a laboratory. The experiments performed were of an investigational nature. Some of his pupils were G. H. Wiedemann, Helmholtz and Tyndall. Later, Lord Kelvin,[2] at Glasgow, entered upon certain investigations of the electrodynamic qualities of matter and, finding the labor of observing too heavy for one individual, invited certain students to aid in the work. Other students desired experimental work of a similar nature and thus was developed a research laboratory in which the students took an enthusiastic interest. The funds of this laboratory were obtained from the university, but, in the beginning, there was no systematic instruction of students similar to that in the laboratories of to-day.

As these two illustrations indicate, the student's physical laboratory had its origin in research. The zeal for new knowledge furnished the enthusiasm and prescribed the methods of work. To-day, apparently, the student enters the laboratory to learn how to perform experiments and to become expert in the use of various devices such as the micrometer microscope, or the optical lever, or the dividing engine, and to familiarize himself with certain methods of measurement, such as the method of coincidences or the method of double weighing. Indeed, quite frequently courses have such titles as "Laboratory practise" and "Electrical measurements."

Jesus claimed that the Pharisees tithed mint, anise and cummin, but neglected the weightier matters of the law. One can not deny the virtue of tithing; neither can one fail to appreciate the educational value of an experiment which requires great care and accuracy on the part of the student. But what about the weightier matters? The chief function of the laboratory is to give the student an intimate acquaintance with the phenomena and the so-called laws. The familiarity of the student with a particular instrument or method is of temporary importance and should be of little interest. Indeed, why should accurate measurements be considered so highly desirable? Do not the thoughtful regret the fact that in the progress of physics so much valuable time must be spent in accurate measurements by the investigators? Does not the physicist seek to obtain the accuracy needed in a particular investigation with the least amount of painstaking effort, and therefore the least time and labor? Accurate measurements are found in research because they are needed to obtain results, and not because they are intrinsically worthy of a scholar's time and attention. Let this be the recognition of accurate measurements in the laboratory of the student.

The Pharisees thought that they were right, and doubtless their attitude can be explained by the powerful influence of tradition. The defect in our present laboratory instruction can be explained in a similar manner. The instructor accepts the laboratory as an approved method of instruction and is not continually conscious of its highest function. The student working under his direction is just "doing laboratory work."

The slavery to method can be resisted only where the true spirit of research is supreme.

[1] Cajori, "History of Physics," p. 291.

[2] From Kelvin's Bangor address, quoted in Gray's "Lord Kelvin," p. 71.

This is the remedy. In a laboratory where such a spirit is always in evidence, the methods and devices become of secondary importance and the emphasis is placed upon weightier matters. This spirit will be maintained only by eternal vigilance. Is this possible other than by means of active research?

The needed reform in laboratory instruction in physics does not demand radical changes in equipment, but it insists that the instructor shall have the spirit of the science, and that he shall minimize the importance of method and magnify the real function of the laboratory. It is useless to claim that the remedy lies in a particular set of experiments or in the proper equipment. Any method or any equipment will eventually enslave the teacher if it is permitted to do so. The remedy lies wholly in the attitude of the instructor. The teacher who has not the true spirit of research can not obtain freedom from slavery to method.

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A NEW GAS VOLCANO IN TRINIDAD

The daily press recently reported that a new island had been thrown up near the coast of Trinidad, with accompanying fire and explosions. This report and the statement appearing in numerous places that the eruption was volcanic has strengthened the impression, already somewhat current, that Trinidad is a volcanic island forming part of the same chain as Martinique, St. Vincent and others of the Windward Islands. There is, however, no true volcanic activity in Trinidad and no volcanic rocks either recent or ancient are known there. The island is formed of highly folded sedimentary and metamorphic strata, and is more properly to be considered as a portion of the South American land mass. The recent eruption near its south coast was due to the sudden escape of a large quantity of gas from the strata that form the submerged coastal plateau, with the consequent ejection of the mud and other materials which had hitherto confined the pressure. Eruptions of this type on a small scale are constantly going on in southern Trinidad, forming the many mud cones and craters to be seen there, and occasionally large outbreaks such as this latest one occur. In all cases the force at work is escaping gas which rises from the gas-bearing sandy and clayey strata, bringing with it fine sediment and salty water derived from these beds.

I visited numerous gas volcanoes in this portion of Trinidad during October but left there just before the recent eruption took place. Mr. Jefferson D. Davis, of Port of Spain, in a letter dated November 6 writes as follows:

> On last Saturday (Nov. 4) land was seen to rise from the surface of the ocean 3 miles southwest of Erin. . . . The gas . . . soon took fire, and the flames must have gone to an enormous height, because they were seen from Port of Spain to shoot into the clouds, and Erin is approximately fifty miles from this place. The country was lit up for considerable time, and great consternation prevailed among the natives. . . . The governor of the colony and a party of officials with a number of prominent people from this place went down yesterday to see the phenomenon, and found a piece of land about three acres in area, about thirty to forty feet above sea-level, in the center of which was a crater. The ground seemed to be the ordinary blue mud, but was very hot, consequently baked dry and hard. Some of the more adventurous visitors went on to the land and walked about for a while, and took home some samples of the clay. Large volumes of gas were coming from the crater at this time, but there was no fire. We learned to-day by telephone that it has taken fire again.

It is also reported that four distinct detonations were heard from Port of Spain after the island had been formed and that the fire continued burning until Sunday morning. Mr A. C. Veatch, formerly of the U. S. Geological Survey, was on board ship at Brighton, Trinidad, just about to sail for New York at the time. He informs me that his notice was suddenly attracted by a great flame that shot up into the sky just at dusk, at ten minutes before six, Saturday evening. Every one thought it was an oil or gas well on fire. With

the first puff the flame rose as a brilliant mushroom-shaped mass, which immediately changed its form to a straight jet of fire that must have risen to a height of at least 1,000 feet. No noise whatever preceding or accompanying the fire was to be heard from Brighton, which is across the low hills within fourteen miles of the place where the new island was formed. The fire disappeared below the horizon in about five minutes, leaving a cloud of smoke that drifted away. No light was to be seen in the sky the rest of the evening, which makes it certain that the flame either became reduced to a very small size or died out entirely.

The point at which this new gas volcano burst from beneath the sea is about two miles off the south coast of Trinidad. The water is shallow and banks are shown in the vicinity on some maps. On one of these banks asphalt is reported to exist. It is likely that gas springs and mud cones have previously existed on the sea floor in the vicinity. The vent lies along the eastward extension of an east-west line of active gas volcanoes and oil springs that traverses the southeastern tip of Trinidad. This line is mapped by Mr. Cunningham Craig, formerly government geologist of Trinidad, as an anticline. Another assumption that may be considered equally tenable is that the gas volcanoes and asphalt cones may follow a zone of faulting. The strata are highly tilted and contorted and afford little definite evidence as to the character of the structural line. The Columbia volcano, the largest of the gas volcanoes in this belt, has formed a broad mound many acres in extent and 50 or 70 feet in height. An explosion had occurred there just a few days before my visit, in the latter part of October, and thrown up a mass of mud around the crater that increased the height of the summit several feet. The sides of this cone as well as of some others in Trinidad, notably the one called "The Devil's Woodpile," are strewn with pebbles and rock fragments that have been ejected from a great depth.

A point of unusual interest regarding the late eruption is that the gas took fire. The reports so far received give no details bearing on this point, but it seems unlikely that the original ignition took place through human agency. If it did not the phenomenon is one which has seldom if ever been recorded before. Two ways suggest themselves in which the gas might conceivably have become ignited through natural causes. One way is that sparks might have been produced by the friction of boulders against each other as they were shot out with the gas. Cases have been reported to me by oil men in which sparks were formed by boulders, projected under great gas pressure from wells, striking the casing and tools, but I have heard of no case in which the gas was lighted. Another supposition is that electric sparks might have been generated similar to those observed in the vapor clouds emanating from Mount Pelée at the time of its great eruption.

ROBERT ANDERSON

THE FUTURE OF THE LONDON ZOOLOGICAL GARDENS

FROM time to time suggestions have been made respecting the transference of the menagerie of the Zoological Society of London to a more suitable site; and naturally when the fate of the Crystal Palace has been engaging the attention of the public, it has been urged that to make it the headquarters of the Zoo would solve the difficulties of both institutions. Certainly the clay soil at Regent's Park is not specially suitable for animals, although it is not as serious a disadvantage as is sometimes supposed.

A chief difficulty with animals in confinement is that the ground on which they are placed rapidly becomes contaminated with organic refuse, and so forms a suitable nidus for harmful bacteria. Whatever the soil may be, it is necessary, in a majority of cases, unless an enormous area is available, to cover it with an impermeable surface; and this treatment is at least as urgent in the case of sand and gravel as in that of clay. The present area of the gardens in Regent's Park is about

34 acres, and more space would make many improvements possible.

A very large increase of space, however, is not necessary. If the government departments concerned would allow the society to use another 20 or 30 acres of the park on lines similar to those suggested in the columns of *The Times* in July last, there would be ample space for the exhibition of animals on the most modern lines. It is impossible to combine satisfactorily an exhibition ground with a place for the breeding or recuperation of animals. For the convenience of visitors, and children especially, the total area of a zoological garden should not be too great; and, if animals are to be seen satisfactorily, they must not be placed in enclosures large enough to let them retreat from the public gaze. On the other hand, for breeding, acclimatization and the recuperation of animals at all out of health, large secluded areas away from the smoke and fumes of a great city are necessary. An ideal menagerie, whether placed in Regent's Park or at the Crystal Palace, should have also a much larger station in the country where visitors are not allowed.

The cost of installing the Zoological Gardens on a new site would be very great. Even if the provisions of the London Building Act could be got over, and the designs for new Zoological Gardens made simple and suitable with regard to structure and material, the total cost of installation, apart from the cost of the animals and the cost of the ground, would reach at least a quarter of a million pounds. Then there is the question of revenue. Regent's Park, it is true, has been rather passed by in the recent changes that have taken place in London passenger traffic; but even with this disadvantage the average annual gate-money now exceeds £20,000, while the income from the subscriptions of fellows approaches £10,000, and is increasing yearly. Access to the Crystal Palace has certainly been much improved, but it is still difficult to get there by rail, while the roads leading to it are among the most congested in London.

Finally, neither the proprietors of the Crystal Palace nor the Zoological Society of London can consider the finances entirely from the point of view of a public menagerie. The Crystal Palace would require a large income to meet interest on capital and various expenses, and it would look for assistance from the revenue earned by the menagerie. In the case of the Zoological Society, the maintenance of a popular collection of living animals, although the chief source of revenue, is only a part of the duty of the society. The introduction of animals of interest only to maturalists, the encouragement and direct assistance of zoological exploration throughout the world, the maintenance of a magnificent zoological library, and holding of meetings for the discussion of technical zoological subjects, and the publication of memoirs containing the results of zoological investigation are an essential part of the operations of the society, and one very difficult to combine with a place of general popular entertainment.—London *Times*.

SCIENTIFIC NOTES AND NEWS

Sir Joseph Dalton Hooker, the great English botanist, has died in his ninety-fifth year.

Dr. George Davidson, eminent for his contributions to geodesy, geography and astronomy, emeritus professor in the University of California, has died at the age of eighty-six years.

Funeral services of the late Surgeon-General Walter Wyman, U. S. Public Health and Marine Hospital Service, were held in St. Louis in the First Presbyterian Church on November 24. On December 3, there were memorial exercises in San Francisco. A special memorial number of the *Weekly Bulletin of the St. Louis Medical Society* is to be issued in memory of Dr. Wyman.

The Nobel prizes were awarded by the King of Sweden on November 10. The three recipients in the sciences, Mme. Marie Curie, of the University of Paris; Professor Wilhelm Wien, of the University of Würzburg and Professor Allvar Gullstrand, of the University of Upsala, were present to receive them.

Professor John Henry Comstock, head of

the department of entomology at Cornell University, has been elected an honorary fellow of the Entomological Society of London.

A PORTRAIT of Dr. John A. Wyeth will be presented to the gallery of presidents of the New York Academy of Medicine by subscription of members.

A PORTRAIT of Professor James Geikie, subscribed for by members of the Royal Scottish Geographical Society, was unveiled by the president at the meeting of the society on November 11. A replica of the portrait was presented to Mrs. Geikie.

MR. C. O. LAMPLAND, of the Lowell Observatory, has recently been elected an honorary member of the Sociedad Astronomico de Mexico and Mr. E. C. Slipher, of the same observatory, has received its medal for his planetary photographs. Dr. Lowell has been an honorary member and a medallist of the society for several years.

PROFESSOR HENRY M. HOWE, of the department of metallurgy, Columbia University, has been elected honorary member of the Cleveland Institution of Engineers, Great Britain.

MR. N. C. NELSON, instructor in anthropology in the University of California, has been appointed assistant curator in the department of anthropology in the American Museum of Natural History. He will assume his duties next June and give special attention to North American archeology.

PROFESSOR J. KÖNIG has retired as director of the agricultural experiment station at Münster, after 40 years of service and has been succeeded by Professor A. Börner, formerly vice-director.

NAVAL CONSTRUCTOR HOLDEN A. EVANS has resigned from the navy to become vice-president of a shipbuilding company.

PROFESSOR RICHARD T. ELY, head of the department of political economy of the University of Wisconsin, has been appointed to represent the United States on the international commission appointed to study government crop reporting in Europe and America, by the International Statistical Institute, recently held at The Hague. Statisticians generally have long been dissatisfied with the character of crop reports, and the purpose of the commission is to bring about an accurate and uniform method of crop reporting in all countries.

PRESIDENT H. S. DRINKER and Professor J. W. Richards, of Lehigh University, were among the thirty-eight engineers who attended the recent meeting in Japan of the American Institute of Mining Engineers.

ASSOCIATE PROFESSOR CHARLES J. CHAMBERLAIN, of the department of botany of the University of Chicago, is at present doing research work in the far east. In the course of his investigations Professor Chamberlain will visit eastern and southern New Zealand, eastern and western Australia and southern and western Africa.

PROFESSOR WALTER B. CANNON, of Harvard Medical School, gives the sixth of the Harvey lectures at the New York Academy of Medicine on December 16, his subject being "A Consideration of the Nature of Hunger."

PROFESSOR ERIC DOOLITTLE delivered a lecture before the University of Pennsylvania Chapter of the Sigma Xi, on December 11, in the Randal Morgan Laboratory of Physics. His subject was "The Recent Discoveries in Stellar Astronomy."

THE memory of Benjamin Franklin, founder in 1740 of the University of Pennsylvania, is to be honored by the erection of a bronze statue at a cost of $10,000, on the tenth anniversary of the class of 1904, college, in June, 1914. The statue will be placed in front of the gymnasium on Thirty-third Street, near Spruce. The statue will be of heroic proportions, and will represent Franklin as he first appeared in Philadelphia as a runaway printer's apprentice. It has been modeled by Dr. R. Tait McKenzie, professor of physical education, who has modeled several medallions for the university and figures of athletes which have attained celebrity for their lifelike postures. The base of the statue has been designed by Professor Henry Cret, of the architectural school.

In memory of Mungo Park and Richard Lander, who explored the course of the river Niger, it is proposed to erect an obelisk of similar design and dimensions to Cleopatra's Needle, on a projecting point of land at Forcados.

Professor Stöhr, director of the Anatomical Institute at Würzburg, died on November 4, aged sixty-two years.

The death is announced of Dr. F. Bente, director for many years of the control station for fertilizers, feeding stuffs, foods and seeds at Ebstorf, Prussia.

Professor Alfred Cole, secretary of Section B, writes that at the annual meeting of the American Association for the Advancement of Science, at Washington, December 27–30, 1911, Section B (physics), will, as usual, hold joint sessions with the American Physical Society. The place of meeting will be at the Bureau of Standards. The ordinary program of papers will be in charge of the officers of the Physical Society, but the two sessions on Thursday, December 28, will be devoted to papers of more general scientific interest and will be in charge of Section B. At the forenoon session of that day the address of the president of the Physical Society, Professor W. F. Magie, will be given, the subject being "Primary Concepts of Physics." This will be followed by a symposium on "The Ether," led by Professor A. A. Michelson, who will be followed by Professor A. G. Webster, C. E. Mendenhall and others. At the afternoon session there will be the address by the retiring chairman of Section B, Professor E. B. Rosa, on "The Work of the Electrical Division of the Bureau of Standards"; a paper by Professor H. A. Wilson, of Montreal, on the "Structure of the Atom" and (probably) one by Dr. S. W. Stratton, on "Physical Work at the Bureau of Standards." Other addresses of special interest to physicists will be that of Professor A. L. Rotch before Section D on "Aerial Engineering" (unfortunately set for Thursday afternoon) and that of the retiring president of the American Association, Professor A. A. Michelson, on "Recent Progress in Spectroscopic Methods," on Wednesday evening, December 27, at 8 P.M. The New Ebbitt House is selected as hotel headquarters for physicists. It is located at 14th and F Streets. Rates, European plan, $1.50 without bath, $2.00–$2.50 with bath. At recent meetings the plan of getting together at one hotel has added much to the pleasure and profit of the meeting. It would be well to reserve hotel accommodation at once. Abstracts of papers to be presented should be sent as soon as possible to the secretary of the Physical Society, Professor Ernest Merritt, Cornell University, Ithaca, N. Y. The program of the meeting will be mailed on December 15. Except by special action of the program committee, no more than ten minutes can be allowed for the presentation of each paper. Attention is also directed to the council rule which *forbids the secretary to place a title upon the program until an abstract (not necessarily for publication) is in his hands.*

The thirteenth meeting of the Astronomical and Astrophysical Society of America will be held at the Carnegie Institution, Washington, D. C., on Wednesday, Thursday and Friday, December 27–29, 1911. This particular time and place have been chosen for an extra meeting for the purpose of bringing the society both as individuals and as an organization into closer touch with the American Association for the Advancement of Science. A joint session with Section A of the American Association for the Advancement of Science has been arranged for Friday morning. The program of this session will include the address by the retiring chairman of Section A, Professor E. H. Moore; a paper on the "Asteroid Problem," by Reverend J. H. Metcalf, and probably, also, a paper by Professor Lewis Boss on his recent stellar researches. On Wednesday evening there will be a reception at the Naval Observatory tendered by the superintendent and staff to the officers and members of the society. On Thursday afternoon the members will visit the Astrophysical Observatory of the Smithsonian Institution.

THE dates for sessions of the American Physiological Society in Baltimore are December 26–29. The council meets in the evening, December 26, and the scientific sessions begin in the morning, December 27, and continue through the morning of December 29. The session in Washington in connection with Section K is planned for the afternoon of December 29. Arrangements are being made for a symposium on *Acapnia and Shock* for this joint session. The headquarters in Baltimore will be at the Hotel Rennert, corner of Liberty and Saratoga streets. Arrangements have been made by which members of the three societies (Physiological, Biochemical and Pharmacological) meeting in Baltimore may dine together at the headquarters on Wednesday and Thursday evenings, and it is proposed that on both evenings the dinner shall terminate in an informal smoker. The scientific sessions of the society will be held in the physiological building of the Johns Hopkins Medical School. Announcement of papers for the Baltimore sessions have been received from the following members: E. B. Meigs, D. E. Jackson, W. E. Garrey, Th. Hough, J. Erlanger, G. Lusk, H. Cushing and C. Jacobson, Y. Henderson, W. P. Lombard, W. Salant, J. A. E. Eyster, A. S. Loevenhart, L. B. Mendel, W. J. Osterhout, C. Brooks, J. J. R. Macleod, R. E. Sheldon, C. J. Wiggers, W. J. Meek, F. S. Lee and A. E. Guenther, F. S. Lee and M. Levine, E. M. Ewing and H. C. Jackson, H. McGuigan, C. W. Edmunds, G. W. Crile, G. W. MacCallum, J. Auer, S. A. Matthews.

THE third annual meeting of the Paleontological Society will be held in the New National Museum building, Washington, D. C., beginning on Thursday morning, December 28, at 10 o'clock. President William B. Scott will preside over the meeting. The program includes a conference on Friday on Ten Years' Progress in Vertebrate Paleontology with papers as follows:

Wm. B. Scott: South American Mammals.
W. D. Matthew: African Mammals.
O. A. Peterson: Artiodactyla.
J. W. Gidley: Perissodactyla.
W. D. Matthew: Carnivora and Rodentia.
W. K. Gregory: Primates, Marsupials and Insectivores.
F. W. True: Marine Mammals.
E. C. Case: Paleozoic Reptiles and Amphibia—a Comparison of Old and New World Forms.
W. J. Holland: Pre-cretaceous Dinosaurs.
R. S. Lull: Cretaceous Dinosaurs.
O. P. Hay: Chelonia.
J. C. Merriam: Marine Reptiles.
Bashford Dean: Paleozoic Fishes.
C. R. Eastman: Mesozoic and Cenozoic Fishes.
H. F. Osborn: Correlation and Paleogeography.
S. W. Williston: Evolutionary Evidence.
W. J. Sinclair: Contributions to Geologic Theory and Method.

Each of these papers is to discuss the following points: (*a*) status of our actual knowledge, and principal material in different museums which has been brought together in recent years: (*b*) theories accepted and rejected in recent years; (*c*) hypotheses on trial; (*d*) important investigations and explorations which should be made.

WE are requested by the chief of the Weather Bureau to announce that in connection with the Washington meeting of the American Association for the Advancement of Science an informal gathering of persons interested in meteorology and kindred subjects will be held at the Weather Bureau buildings, 24th and M streets, N. W., Thursday afternoon, December 28, from 5 to 7 P.M. The location is easy of access viâ the Pennsylvania Avenue car-line, by which many members of the association will be returning from the cavalry drill at Fort Myer, the same day. The drill is from 3 to 4:30 P.M. The proposed gathering will be analogous in character and purpose to the "meteorological luncheon" of the British Association, and its promoters hope that a meeting of this kind may become an annual event. A series of five-minute talks will be given by leading men of science on the general subject, "The Relation of Meteorology to other Sciences." The scope of the discussion will be broad enough to interest every one, and it is hoped that the attendance may be general on the part of members of the association and

their friends, including ladies. The visitors will be given an opportunity of inspecting the installations and work of the bureau.

The annual meeting of the American Anthropological Association in affiliation with Section H of the American Association for the Advancement of Science and the American Folk-Lore Society will be held December 27–30 in Room 28, U. S. National Museum (new building), Washington, D. C., instead of in the Public Library as previously announced.

Nearly a hundred students from the College of Engineering of the University of Wisconsin are now on their yearly tour of inspection of great engineering plants of the east. Engineering plants in Chicago, Milwaukee, Niagara Falls, Pittsburgh, Schenectady, N. Y., and New York City will be visited. These tours are required of students of engineering during their junior and senior years and are arranged to cover industries that illustrate the work of the course pursued by the student. Professors A. G. Christie, George J. Davis, J. R. Price and A. L. Goddard accompany the students on the trip.

A site for the Memorial Institute for Infectious Diseases, Chicago, to be built with funds bequeathed by Mrs. Annie W. Durand, has been selected and purchased at the corner of Wood and York Streets with a ground area of 100 by 126 feet. The building will be four stories and a basement in height and will cost with its equipment about $200,000.

UNIVERSITY AND EDUCATIONAL NEWS

Williams College will receive approximately $100,000 by the will of Miss Sarah H. Pattison, of Ossining, N. Y. The money is to be used for the library.

Throop Polytechnic Institute, at Pasadena, California, through the generosity of an anonymous donor, has announced two annual prizes—a senior scholarship prize of $750, to be used for a trip to Europe, and a freshman scholarship prize of $250, to be used for a trip through some of the principal cities of the eastern United States. The senior prize will be awarded to the student who has the best record in scholarship for the junior and senior year, "the faculty taking also into account, in assigning the award, considerations of deportment or good manners and ability for original work." The freshman prize will be awarded to the freshman who has the best scholarship record for the year, "good manners and the quality of initiative being also taken into account."

The official list of changes in the instructing staff of the Massachusetts Institute of Technology shows that there have been forty-three replacements of last year's professors or instructors plus five additions, forty-eight new men. Chemistry and electric engineering are the departments in which the largest additions have been made. In chemistry the changes include the promotion of five instructors or assistants and the addition of six. In electrical engineering three additional instructors may be noted.

The following appointments have been made at Cornell University: Herbert A. Hopper, assistant professor in extension work in animal industry; T. E. Schreiner, assistant in the department of poultry husbandry; G. H. Miller, assistant in pomology for the winter course; William C. Hooey, assistant in chemistry.

Dr. M. T. Cook has resigned as plant pathologist in the Delaware Station to become professor of plant pathology in Rutgers College and plant pathologist in the New Jersey College Station.

Mr. Frank E. Hermanns has been made the head of the structural engineering department at the Stevens Institute of Technology.

At Cornell University the work in farm management has been organized as a separate department, with G. F. Warren as head, K. C. Livermore as assistant professor and A. L. Thompson as instructor. The work in farm crops has been united with the department of farm practise and is in charge of Professor J. L. Stone.

Mr. H. A. Wadsworth has been appointed assistant professor of forestry in the school of forestry of the University of Idaho.

DISCUSSION AND CORRESPONDENCE

"GENOTYPE" AND "PURE LINE"

THE widespread interest in the lectures on genetic problems now being given in this country by Professor W. Johannsen makes it worth while to point out certain diversities in the usage of terms introduced by him—diversities giving an appearance of disagreement where none exists. The fact that the present writer is partly responsible for any confusion thus caused impels the publication of this note.

The term *genotype* was introduced by Johannsen in connection with the term phenotype. The latter designates a group of organisms which in outward appearance seem to belong to one type, although in hereditary constitution they may actually differ greatly. *Genotype,* in Johannsen's usage, is not directly contrasted with phenotype, to signify a group of organisms that actually do possess in all respects the same hereditary constitution—though this is the sense in which some of us have been using it. It arose as follows. Organisms with hereditarily different constitutions must have different combinations of the determiners, called by Johannsen *genes,* that decide what the somatic characters shall be. They have, then, different typical combinations of genes. Johannsen calls the particular combination of genes that an organism has, its genotype. Or, without reference to genes, we might say that the genotype of any organism is the particular combination of hereditary features that characterize it. Thus, as employed in Johannsen's usage, genotype is an abstract term.

When a group of organisms all have demonstrably the same combination of hereditary characteristics, one can say that they have the same genotype, or that they belong to the same genotype. From this it is but a step to the employment of the word as a name for such a concrete group of organisms, all with the same hereditary characteristics. Following a bent toward concreteness, I have used the term in this way in my paper on "Pure Lines in the Study of Genetics in Lower Organisms."[1] Shull has done the same in his paper on the "Genotypes of Maize";[2] apparently this use of the term for a concrete, visible group of organisms is becoming general; for a term with this precise meaning is much needed. But this is not the usage of Johannsen.

Thus arise such differences as that shown by my own characterization of genotypes as "concrete realities," as "actual existences that strike you in the face," etc.,[3] when compared to Johannsen's statement that "we do not know a genotype," etc.,[4] and that this is a concept with which we cannot actually operate.[5] There thus arises an appearance of opposition where none exists. What I and some others have called a genotype is what Johannsen would call a group of organisms "identical in genotypical constitution." The usage recommended by the originator has of course the right of way.[6]

A diversity of usage likewise exists as to the expression "pure line." I have employed this to designate a genealogical series in which there arises no diversity in hereditary characteristics, either from within or from without; such, for example, as the series produced by the repeated fission of a single infusorian. Pure lines in this sense might be expected, from what we thus far have learned, (1) in cases of vegetative reproduction, (2) in at least some cases of parthenogenesis (where no reduction division occurs), (3) in case of self-fertilization of homozygotic organisms, (4) in case of inbreeding of a group of genotypically identical homozygotic organisms.

The pure lines investigated by Johannsen fall in the third group, and he employs their

[1] *Amer. Nat.,* February, 1911.

[2] *Amer. Nat.,* April, 1911.

[3] *L. c.,* p. 80.

[4] *Amer. Nat.,* March, 1911, p. 134.

[5] "Elemente der exakten Erblichkeitslehre," p. 130.

[6] Whether the word itself should be given up, in this connection, because it had earlier been used in an entirely different sense, is of course a different question.

characteristics as his definition for pure line. "A pure line may be defined as the descendants from one single homozygotic organism exclusively propagating by self-fertilization."[1] It appears that we need badly a term that will include "genotypically identical" series of forms arising in other cases than this one, so that it is difficult to give up the use of the term in this wider meaning.

H. S. Jennings

Mosquito Romance

In the issue of Science for September 15, pp. 350–351, Dr. John B. Smith reviewed a book by Edward H. Ross—"The Reduction of Domestic Mosquitos." While Dr. Smith indicates that the book does not meet the general needs of those to whom the title is obviously meant to appeal, he intimates that it will be valuable "in warm climates." Other reviews of the book have appeared in terms of unqualified praise. The most recent of these is in the November number of *Entomological News*. Furthermore, the book has been well advertised among those who might need useful information on this now important subject. Under the circumstances the writer considers it his duty to protect fellow-workers by indicating the true character of the book.

The author restricts himself to the two principal house-mosquitoes of the tropics, *Stegomyia calopus* and *Culex fatigans*, and the problem of their control. But instead of facts we get an array of well-worn generalities, and, where he deals with the life histories of the insects, of pure fabrications. It would be a waste of valuable space to discuss this book *in extenso;* a few choice blossoms are culled herewith for the benefit of the uninformed.

The book is avowedly economic and biological, but, lest the reader think the systematic side is negligible, we quote the following: "Fabricius in 1805 first designated the 'tiger' mosquito, *Stegomyia fasciata*, although Villiers[1] had probably described the same insect before; Meigen called it *Stegomyia calopus* very soon after. In 1825 Latreille grouped mosquitos generally under the name Culicidæ, but only three genera were known, *Anopheles, Culex* and *Ædes.*" Alas for Meigen and for Theobald!

Chapter II. deals with "the life and habits of mosquitos." One of the first statements we find here is that "the hæmatophagous habit appears to be dependent on the presence, in the female, of the spermatozoa of the male." The author deduces this from the fact that all the females with blood in the stomach dissected by him contained spermatozoa in the spermathecæ. "From this it must be inferred that virgin females do not, commonly, take blood"—surely a simple piece of reasoning! We are then favored with some amusing speculative remarks on this unusual phenomenon. A most remarkable belief of the author is that the female *Culex,* after disposing of her eggs, seeks another male and, after being again fertilized, produces another raft of eggs, and then over again, apparently *ad infinitum.* This absurd belief is, of course, purely a product of the author's imagination and it is controverted by a formidable array of established facts, of which, however, our author is blissfully ignorant. Considerable space is taken up with the reiteration of this notion and the author returns to it again and again. "If a female lays a whole egg-raft or complete brood, she exhausts all the spermatozoa within her spermathecæ and then she must again cohabit with a male in order to be replenished. This is the reason why males are likely to remain in or resort to the places where the females commonly lay their eggs. For example, in houses, the males of the Culecines are commonly found in the water-closets. The females are attracted there by the seal-water,

[1] Johannsen, *Amer. Nat.*, March, 1911, p. 135.

[1] The author's name is de Villers. He described a *Culex fasciatus* in 1789. Independently Meigen, in 1804, and Fabricius, in 1805, described other mosquitoes under the same name. The last of these was the species here considered, but the name is preoccupied by the two earlier homonyms; consequently (*Culex*) *calopus*, the name under which it was later described by Meigen, had to be adopted. The genus *Stegomyia* was established by Theobald in 1901.

for they know that their children will thrive therein; and also that as soon as they have laid their eggs the males are ready to fertilize them again. The eggs exude their larvæ into the seal-water of the closet, the latter are washed down into the cesspool where the water is at an even temperature, and where there is plenty of food for them; so the perpetuation of the species is assured. As the female lives so much longer than the male, her second and third fecundations are brought about by the males of succeeding generations to her own." With modern improvements an up-to-date female mosquito does not even lose time by going down stairs to dispose of her eggs! Further interesting information is that "the larval metamorphosis includes the pupa stage." Most opportune comes the statement: "Both the larva and the pupa are not fish, but insects." *Notonecta* is well known as an enemy of mosquito larvæ and we here learn that "it can hop from one puddle to another. It is a water-beetle, but is rendered powerless against mosquito larvæ when the pond becomes full of green weed, which hampers its movements."

But the acme is reached in Chapter IX., entitled "Mosquito Reduction." This chapter does not, as one would suppose from the title, give useful instruction in the control of mosquitoes. Casting aside the fetters of science, the author soars into the boundless realm of pure imagination. He takes an imaginary female mosquito from the time she emerges from the pupa, through a series of hair-raising adventures, to the end of her life. The story is made fascinating by the author's treatment of mosquito psychology. "The room was almost dark. She settled at once on the mosquito net, waving her hind-legs in an expectant way. The thoughts of a meal made her feel a pleasurable excitement, but she also felt, instinctively, the need for caution." . . . "The wind and disturbance he made with his arms caused the mosquito to fly away to a far corner of the room, and contemplate with quaking thoughts the difficulties of obtaining the necessaries of life." . . . "When on the child's net she noticed that there were a score or so of mosquitoes like herself, with their bodies distended with blood. But there were only two males among them, and they both belonged to an alien species, and they had not fed on the child. What had become of the swarms of males that she had left in the cesspool? She wondered why it was only her sex that required blood. Why had she to risk her life for food while her husband and brothers remained contentedly in their home, the cesspool?" After a series of blood-letting and egg-laying adventures, in which our mosquito shows a considerable capacity for acquiring wisdom, we finally get to the point of the story. The mosquito brigade has been busy, the breeding places have been either oiled, drained or screened.

"Six weeks later she had another brood of eggs to lay. The fountain was now dry. She searched high and low, but there was no water anywhere that was suitable for her eggs; also there were no male mosquitos. All the cesspools contained petroleum, and even the cisterns were screened with wire gauze. So she laid her eggs in some clean water in a basin, but the larvæ died for want of food. She searched for a male mosquito of her species to consort with again; he could not be found. There were no mosquitos at all. Then the craving for blood seemed to forsake her. She became a vegetarian, living on the juices of old banana skins and discarded watermelons. But her life, once so full of adventure, was blasted, and she died disappointed, but with the knowledge that she had lived."

It should be added in closing that several chapters are devoted to directions for making estimates of cost for mosquito-control work, and principally how to wheedle the necessary money out of reluctant authorities, corporations or private individuals.

The appearance of the present work is the more astounding when one compares it with another work which appeared six years ago, as a byproduct of similar activity to Mr. Ross's and in the same locality (the Isthmus of Suez). The work referred to is Dr. Pressat's "Le paludisme et les moustiques" (Paris, Masson et Cie, 1905) which must still be

looked upon as a standard in this class of literature.

KONOPS

HOW A FALLING CAT TURNS OVER IN THE AIR

TO THE EDITOR OF SCIENCE: In a lecture on the gyrostat before the Washington Society of Engineers, I gave a valid explanation of how a cat is able to light on his feet when he is dropped back downwards. After the lecture Professor J. F. Hayford was kind enough to call my attention to what is no doubt the actual character of this cat performance, and I give a statement of it herewith for the readers of SCIENCE. However, I prefer the idea I had formerly of the cat performance, because I am able to do it myself, not indeed while falling through the air but while standing on a pivoted stool. It is my impression that the idea I had formerly is the generally accepted idea of the cat performance, but it is difficult to explain, although easy to perform.

The curved figure in the accompanying sketch is a conventionalized cat which is let fall back downwards, and the question is how can a cat (not so highly conventionalized) turn over and light on its feet.

FIG. 1

FIG. 2

There are two simple types of motion of the cat's body which give spin momentum around the axis AB, namely, (a) a rotation around AB as an axis of the cat's body as a rigid structure, and (b) a sort of squirming motion in which each part of the cat's body rotates about the curved line CD.

The amount of spin momentum due to a spin velocity a of the first kind is Ka, and the amount of spin momentum due to a squirming velocity b of the second kind is kb; and the factor k' is always less than the factor K when the cat's body is curved.

Now suppose the falling cat to exert the muscular action necessary to produce and maintain a squirming velocity b; then the cat's body will simultaneously be set spinning in the first mode at spin velocity a such that

$$Ka + kb = 0$$

or

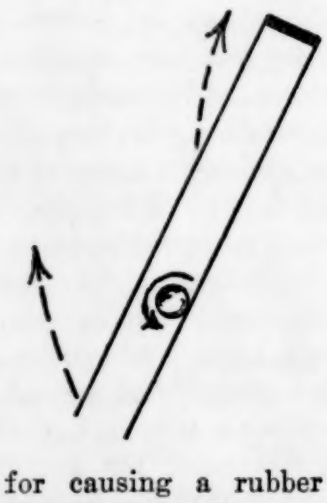
$$b = -(K/k)a,$$

because no spin momentum can be produced by forces inside the cat. Therefore a and b are opposite in sign and b is greater than a. Suppose, for example that b is twice as great as a; then while the cat squirms one complete revolution ($bt = 360°$) his bent form will rotate backwards through half a revolution ($at = 180°$), and the cat will be in the position shown in sketch No. 2, because each part of his body will have rotated through the angle $360° - 180°$ which is $180°$.

W. S. FRANKLIN

HOW TO THROW A CURVED BALL

TO THE EDITOR OF SCIENCE: I have tried a great variety of devices for throwing a curved ball for class-room demonstration, but with only moderate success, and I have tried in vain the method suggested by Professor J. J.



Thomson for causing a rubber balloon to travel in a sharply curved path. A year ago, Professor J. H. Wily suggested a method which is extremely satisfactory, as follows:

[1] This factor is not a moment of inertia in the usual sense of that term; but it is expressible in terms of the same unit.

A light ball of pith or cork or a ping-pong ball covered with varnish and rolled in fine sawdust is placed in a round pasteboard mailing tube and thrown by a quick motion of the tube as indicated in the accompanying sketch. The ball rolls along one side of the tube and is spinning rapidly when it leaves the end of the tube. The result is that the ball curves sharply upwards as it flies through the air, in some cases describing the cusped curve which is mentioned by Professor J. J. Thomson.

W. S. FRANKLIN

SEED DISTRIBUTION BY SURFACE TENSION

IN response to Mr. Becker's suggestion in SCIENCE, November 17, I may record what I have been accustomed to state in public concerning the distribution of seeds of water lilies (*Nymphæa* (L.) Sm.). Indeed, I was surprised to find that the observation had not already been published.

The fruits of *Nymphæas* mature under water, and burst irregularly, discharging the seeds a few inches or feet below the water surface. But the seeds rise at once and float by reason of a buoyant aril. The aril forms a kind of double-walled sac, open at one end, and enclosing the seed. It is mucilaginous in character and carries little bubbles in and upon it. I have often watched a mass of such seeds of *N. odorata, N. cærulea* or *N. lotus* upon a water surface. They separate from one another spontaneously and distribute themselves over the tank or pond in all directions, even though both water and atmosphere be perfectly still. It is wonderful how they steer about among floating leaves, and travel to the confines of their basin. Each one seems to repel all others. I have always believed this was due to surface tension or diffusion effects, but have never undertaken to prove the point or to determine the substances causing it. After some hours, the aril splits, the pieces curl up, and the heavy seed is released and sinks to the bottom of the pond.

HENRY S. CONARD

GRINNELL COLLEGE,
GRINNELL, IOWA,
November 20, 1911

MODELS OF VORTICELLA AND CYCLOPS

TO THE EDITOR OF SCIENCE: The Department of Animal Biology of the University of Minnesota recently received a model of a small colony of *Vorticella* and a model of *Cyclops* that deserve public notice.

These models are advertised in reputable catalogs and the stands bear printed labels that announce:

Awarded Gold Medal, Franco-British Exhibition, 1908

Biological Models. Made by Smedley, London, S. E. Sole Agents, Gallenkamp & Co., 19 and 21 Sun St., Finsbury Square, London, E. C.

The models are made of a soft paraffin and are, without qualification, the poorest models that I have ever known to be advertised and for sale. They are absolutely devoid of any scientific value and are grossly untrue to even the most evident structural features. The appendages of the *Cyclops* (sp.?) are uniramous and no attempt has been made to indicate the relative lengths of the joints. Even the number of joints differs in the members of a pair. There is no attempt to represent the vestibule or "disk" of the *Vorticella* and the cilia are represented by feathers pressed into the paraffin. The paraffin is very slovenly put over wires and everything about the models indicates very crude workmanship and lack of knowledge. And such things are awarded gold medals!

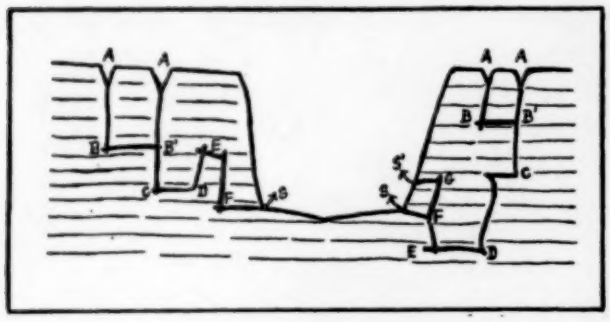
This is submitted for the protection of those disposed to use models in the class room and the laboratory.

HENRY F. NACHTRIEB

SIPHON SPRINGS AND SINK HOLES

Siphon Springs.—Intermittent springs as the result of the combination of a reservoir and siphon have long been favorite illustrations in the standard text-books of physics to show the practical application of the siphon. The familiar figure shows a small hill with a large cavern discharging its water by means of a siphon. Such a cavern emptying into a valley in this way must be extremely rare in

nature, if it ever occurs, and physiographers have done well (and physicists would do well) to omit it from their text-books. But in a modified form the siphon is probably occasionally operative. A figure which, although imperfect, is more in accord with the structure of limestone strata and the effect of solution upon them is given by de Martonne ("Traite de Geographie Physique," 1909, p. 347, fig.



147*A*). In this case (Fig. 1) the joints of the rock are shown to be widened by solution in such a manner as to make a siphon spring (*s*) possible. On the left a normal siphon is shown in which the spring does not flow until the reservoir *ABCD* is filled to *B*, that is, until the water begins to flow through the long arm *EF* of the siphon. On the right of the valley is an inverted siphon. It is perhaps unnecessary to state that although intermittent springs are the commonest of all springs the intermittent character seldom depends upon the presence of a siphon.

Sink Holes.—Sink or swallow holes are formed in one of two ways: (1) by the falling in of the roof of a cavern and (2) by the solution and erosion of the rock along joint or fault planes, the latter being by far the commoner origin. American writers of text-books of geology and physiography usually give but one explanation of the origin of these features and that the first and most unusual. Only two authors, as far as the writer is aware, give both. The popularity of the first explanation is probably due to the fact that the word "sink" implies a sinking in of the surface as well as the disappearance of the water by pouring into a funnel. The suggestion is offered that the older (?) term "swallow" hole be used, since it carries with it only the thought of the disappearance of the water in a throat or funnel.

Herdman F. Cleland
Williamstown, Mass.,
November 3, 1911

The Rôle of Salts in the Preservation of Life

In my address on "The Rôle of Salts in the Preservation of Life," published in No. 381 of Science, I made the following statement "Several authors, Lillie, McClendon and Lyon, have suggested that the fertilized egg is more permeable to salts than the unfertilized egg." Mr. R. Lillie calls my attention to the fact that he never made this suggestion. I feel it my duty not only to express my regrets for my oversight but to add that if my paper had dealt fully with the literature of the subject Mr. Lillie's ingenious experiments and original ideas should have occupied a prominent place in it, as those who are familiar with the subject will fully realize.

Jacques Loeb

Scientific Books

Observations and Investigations made at the Blue Hill Observatory, Massachusetts, U. S. A., in the Years 1906, 1907 and 1908, under the Direction of A. Lawrence Rotch. Annals of the Astronomical Observatory of Harvard College. Vol. LXVIII., Part II., 4to. Cambridge, Mass. 1911. Pp. 99–229, Figs. 15.

The work of the Blue Hill Observatory needs no introduction to the readers of Science. The progress of that unique institution, so important for American meteorology, has been faithfully recorded in the columns of this journal ever since the foundation of the observatory in 1884. Meteorologists have long since learned that the Blue Hill volumes of the *Annals of the Harvard College Observatory* are sure to contain results worthy of careful note and study.

Volume LXVIII., Part II., of these *Annals* contains the observations made twice daily in 1906–08; the usual summaries; results from the kite meteorograph and simultaneous records at the ground 1906–08; data obtained by means of *ballons-sondes* at Pittsfield, Mass., in 1908; supplementary data for a manned

balloon ascension from North Adams, Mass., July 29, 1908, and three memoirs. The first of these memoirs is by H. H. Clayton, on "A Study of Clouds with Data from Kites." Mr. Clayton has devoted himself so closely, for years, to the study of clouds and of kite data that this subject may in a very real sense be called peculiarly his own. The investigation is a very interesting one to all who have made any observations of clouds, and throws much light on many hitherto obscure points in cloud formation. In fact, it is one of the most suggestive discussions of the methods of cloud formation which has been published. The data used included all the measurements obtained up to January, 1909. A series of simple diagrams makes clear each step in the discussion. Cumulus clouds are found to be obviously caused by condensation in bodies of ascending air. Alto-stratus, alto-cumulus and cirro-stratus are probably formed in a stratum of air which is rising at a slight angle to the earth's surface. Strato-cumulus, on the other hand, is formed by a combination of local ascending currents and an ascending sheet of cloud. All clouds are found to be closely connected with inverted temperature gradients, the top of the cloud being usually in the coldest air immediately beneath the inverted gradient of temperature, and the height at which cloud formation can take place in the lower air being determined by the height above sea-level of the lowest inverted temperature gradient. The height above sea-level of the lowest inverted gradient of temperature and the complement of the dew-point determine whether days shall be cloudless or partly cloudy. There is thus a possibility of making practical use of the temperature and humidity observations obtained in the free air by means of kites and balloons for predicting the probable formation of various clouds, and therefore the probable weather that will follow. Mr. Clayton has left the staff of the Blue Hill Observatory, with which he was connected for nearly 23 years. His work there is well known to meteorologists the world over. His present study of clouds is perhaps the last memoir by him which will appear in the *Annals of the Harvard College Observatory*. It seems to us singularly appropriate that this particular study should have to do with kites and clouds, two lines of investigation which Mr. Clayton has done so much to further, and in which he has so unusually distinguished himself.

There are two further discussions, by Andrew H. Palmer, who has recently joined the staff of the observatory as research assistant, after leaving the graduate school of Harvard University. The first of these, on "Wind Velocity and Direction in the Free Air," deals with a subject concerning which the Blue Hill observations are able to supply valuable original data. There were used in this study the data obtained during 234 kite flights, made in 1897–1908; the cloud observations of 1890–91 and of 1896–97, and the *ballons-sondes* data from St. Louis, 1904–07. The principal results are as follows: (1) the general increase in velocity with height; (2) the rare occurrence of gusts of wind above low heights; (3) the frequent clockwise and occasional counter-clockwise changes of direction with height; (4) the shallow character of easterly winds; (5) the relative frequency of ascending currents as compared with those descending. It is easily seen that such results as these are of immediate practical importance in connection with aviation. Indeed, it is significant that both Mr. Clayton's study of clouds above referred to, and this one of Mr. Palmer's have such distinctly practical bearings.

A second paper by Mr. Palmer concerns "Pressure Oscillations of Short Wave-length." It appears that the pressure oscillations of short wave-length at Blue Hill are of two types, (1) those of 1–3 mm. amplitude, recurring irregularly over a period of several hours, and (2) those consisting of a single wave of 2–3 mm. amplitude occurring with certain thunderstorms. The former are due to the undulations set up at the horizontal boundary between two air strata of which the upper is the lighter, and in which the rate or direction of movement of one differs from that of the other. Type (2) seems to be

caused by the convectional currents in the agitated air mass of a thunderstorm. Comparatively little attention has thus far been paid to these short wave-length pressure oscillations, and Mr. Palmer has extended our knowledge of them by his examination of the Blue Hill records.

To have built and equipped, and to have maintained for more than 25 years, an observatory such as that on Blue Hill, which has done so much real pioneer work of the highest importance—surely this is a splendid contribution to science. To Professor A. Lawrence Rotch American meteorology, indeed meteorology everywhere, owes a debt which is year by year becoming greater.

R. DeC. Ward
Harvard University

Rock Minerals: Their Chemical and Physical Characters and their Determination in Thin Section. By Joseph P. Iddings. Second edition, revised and enlarged. New York, John Wiley & Sons; London, Chapman & Hall, Limited. 1911. Pp. 617. Cloth. $5.00.

That a second edition of Professor Iddings's work has so soon been called for speaks well for the growth of American petrography, while the constant tendency manifested toward a greater degree of refinement in methods speaks well for its future growth.

The present edition, so far as its plan is concerned, is practically identical with the first, the important difference being the addition of such new material as brings the work down to date. Upwards of 80 minerals are described not included in the first edition; "chiefly those occurring in pegmatites and segregated ores representing extremes of magmatic differentiation." Fifty-two figures are added in the text, and 67 pages of descriptive matter: a birefringence diagram is also added. Incidental to this diagram and the colored plate indicating the interference colors and birefringence of the various minerals it may well be asked if students entering upon the study of micro-petrography are ever tested for color blindness. It has often seemed to the reviewer that sundry imperfect (rather than erroneous) descriptions which have been published might be due to an inability on the part of the worker to distinguish the various colors, or at least to distinguish between their relative values.

The book, as in the previous edition, is divided into two parts, Part First, Chapter 1, being given up to a description of chemical principles and characters, and is identical with the edition of 1906. Chapter 2, dealing with the physical principles and characters, is also identical with the 1906 edition, and leaves nothing to be desired in its method of presentation. Chapter 3, on the optical properties, deals with what is perhaps the most difficult branch of the science for the student to master, and is naturally the most difficult to handle in a manner satisfactory to both worker and student. It demands the knowledge and the experience of the advanced worker and yet the teaching capacity of one who has not so far outgrown his student days as to be unable to appreciate the necessity of carefully detailed presentation. With the advanced student this chapter leaves little or nothing to be desired. As, with the exception of a page and a half on pleochroic halos, it is identical with the previous edition, nothing more need be said here regarding it.

Part 2 deals with the description of the various rock minerals taken up in the order of their chemical composition; alteration; crystallographic characters; optical properties; modes of occurrence; resemblances to other minerals, and laboratory production. It is to this portion of the book that the worker, however advanced, must have constant reference.

Professor Iddings is recognized the world over as an authority in all matters relating to petrography, and words commendatory are superfluous. The work is simply indispensable to all petrographers. The method of presentation is, however, naturally open to discussion. To the reviewer it would seem that for actual use and for purposes of ready reference more discrimination might well have been shown between minerals prominent as rock constituents and those rare: between

tests that may be applied to determine in the easiest and quickest way what a mineral actually is, and others which, though they may be of equal scientific interest, are unimportant or inapplicable. In its detail the work is monographic and if this is what the author had in mind there is naturally nothing more to be said. Criticisms along these lines are often unfair, being based upon what a reviewer thinks he has a right to expect rather than what the author intends. Whatever may be one's views on these subjects there is always the comforting reflection that the information given is as accurate as the stage of the science will permit.

The make-up of the book is the same as that of the first edition. The paper and binding are good, the type clear, and the illustrations excellent. Petrographers are to be congratulated that so able an authority has found time to put the knowledge gained by many years of study and experience into a form available for students the world over.

GEO. P. MERRILL

The British Nudibranchiate Mollusca. By ALDER and HANCOCK; Supplement by SIR CHARLES ELIOT. London, Ray Society (Dulau & Co.) 1910. 4to. Pp. 198. 8 plates.

Of works on this attractive group of mollusca, that of Alder and Hancock is *par excellence,* the classic, not only on account of its exquisitely beautiful and accurate plates, but from its monographic character and correct anatomical details. Among the posthumous papers left by the two authors were notes and drawings preliminary to a supplement to the original work.

To forty-two of these drawings Sir Charles Eliot has added twenty-three new ones and supplied a text, the whole being sent out by the Ray Society with suggestions for the completion of imperfect copies of the old work possessed by individuals interested in the subject. The form is that of the original monograph and the quality of the plates fully equal to that of the first issue.

But the author has not been satisfied with the preparation of a merely descriptive and corrective supplement. He has prefixed to the purely systematic portion chapters on variation and distribution, bionomics, embryology and larval stages, general classification of the group and an exhaustive discussion of the affinities and relationships of the animals concerned. These chapters not merely illuminate the subject but are from a merely literary standpoint presented in a form so clear and interesting as to be readable with pleasure by one having only a general knowledge of the mollusca. Such contributions to zoology are likely to invite study of the animals treated, and it is to be wished that works of this quality were more common.

WM. H. DALL

Duc d'Orleans, Campagne arctique de 1907. Par CHARLES BULENS. Bruxelles. 1910–11. *Etude lithologique,* par J. THOULET; *Echinodermes,* par JAMES A. GRIEG; *Mollusques et Brachiopodes,* par PHILIPPE DAUTZENBERG et HENRI FISCHER; *Microplankton des Mers de Barents et de Kara,* par le DR. ALPH. MEUNIER; *Faune des Mousses: Tardigrades,* par FERD. RICHTER; *Journal de Bord, et Physique du Globe,* par A. DE GERLACHE, etc.; *Appendice, Sondages de 1909,* par A. DE GERLACHE; planches et cartes.

The steamer *Belgica,* well known for her explorations in the Antarctic seas, has been engaged in Arctic exploration of late years, under the auspices of the Duke of Orleans and commanded by Commandant A. de Gerlache de Goméry. In 1907 the expedition left the northern coast of Norway at Hammerfest and Vardö, crossed the Murman Sea, circumnavigated the southern island of Novaia Zemlia, skirted the west coast of the northern island, penetrated to about latitude 78° in the Polar Sea, taking numerous soundings, before returning to Norway. In 1909 hydrographic explorations and soundings were made in the Greenland seas. By the munificence of the patron of the expedition the scientific results of the work are appearing in a series of finely illustrated and beautifully printed quartos. A summary of the titles of those which have

reached us appears in the heading of this article, the parts enumerated comprising 578 pages, 7 charts and 50 plates. Of this the larger part is comprised in a monograph of the Microplankton which takes up 355 pages and an Atlas of 37 plates. Lists of the birds and mammals observed are given in the "Journal." The mosses were extensively collected and contained an extensive fauna of minute invertebrates, of which the Tardigrades are described by Dr. Richter, about 30 species were obtained, of which five proved to be new. A minute copepod crustacean, *Moraria muscicola* Richters, which has adapted itself to a terrestrial habitat, was among the other animals found in the moss. The dredgings produced thirty-eight species of mollusks and two brachiopods, all well-known arctic forms. The Echinoderms included twenty-five species, a Crinoid, nine Ophiurans, eleven starfish, an echinus and three Holothurians, none of which proved new, which is not astonishing, since so many exploring expeditions have visited this region. The specimens of bottom obtained conformed in general to the character of soundings previously made in the Polar seas. The specimens studied are rich in garnet, pyroxenes and basaltic magmas, but showed no meteoric particles and were poor in magnetite. More than seventy soundings were made, of which nineteen were carefully analyzed. In the matter of terrestrial physics meteorology is discussed by Commandant de Gerlache, magnetism by A. Nippoldt and atmospheric electricity by G. Ludeling. The charts are from the latest researches published by the Russian Admiralty.

Altogether the present contribution adds a worthy member to the long list of publications on the ever interesting problems of the Arctic region.

Wm. H. Dall

Modern Geography. By Marion I. Newbigin. New York, Henry Holt and Company. 1911. Pp. 256.

Newbigin's "Modern Geography" is Volume 7 of the new Home University Library of Modern Knowledge, established by Williams and Norgate of London. It is a popular volume, aiming to summarize in two hundred and fifty pages the content of geography as now understood. Four chapters are devoted to the history of geography since the doctrine of evolution has revolutionized modern thought, to the development of surface forms and to climate and weather. Four chapters are devoted to the geography of plants and animals and the Races of Europe. The final chapter considers the Distribution of Minerals and the Localization of Industries and Towns.

The chapters are necessarily brief and in no case is it possible for the author to consider any topic in a really satisfactory manner; and yet the new ideas are outlined in simple, untechnical language, and with sufficient fullness to give the gist of modern thought, in every case. The reader will not, as is so frequently the case in volumes of similar scope, gain the impression that all has been said that might be said on any subject. He will, on the contrary, be naturally and easily led far enough into the subject to become interested in it and desire to learn more about it. A carefully selected list of references given in the appendix presents the reader with the logical next step in his advancement. Throughout the volume the author writes with a real geographic instinct and constantly inserts examples of the influences of physical conditions on life distribution and relations. In this way geography is shown to be a subject not merely of broad generalizations, but of real significance in understanding some of the common things of every-day life. Except in the chapter devoted to Plant Geography, where the author considers the plant formations of Eurasia and North America, but little attention is given to American conditions, and few illustrations of geographic relations are taken from the rich offering of our own continent.

Though the volume is thus European in tone, it is not by any means without value for readers in this country. It is a suggestive volume, interestingly written, that should appeal to the general reader, and offers many suggestions to the geographer, though he may

feel dissatisfied that it is not more complete in scope.

RICHARD E. DODGE
TEACHERS COLLEGE,
COLUMBIA UNIVERSITY

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES

THE American Association for the Advancement of Science and the national scientific societies named below will meet at Washington, D. C., during convocation week, beginning on December 27, 1911.

American Association for the Advancement of Science.—President, Professor Charles E. Bessey, University of Nebraska; retiring president, Professor A. A. Michelson, University of Chicago; permanent secretary, Dr. L. O. Howard, Smithsonian Institution, Washington, D. C.

Section A—Mathematics and Astronomy.—Vice-president, Professor Edwin B. Frost, Yerkes Observatory; secretary, Professor George A. Miller, University of Illinois, Urbana, Ill.

Section B—Physics.—Vice-president, Professor Robert A. Millikan, University of Chicago; secretary, Professor A. D. Cole, Ohio State University, Columbus, Ohio.

Section C—Chemistry.—Vice-president, Frank K. Cameron, U. S. Department of Agriculture; secretary, Professor C. H. Herty, University of North Carolina, Chapel Hill, N. C.

Section D—Mechanical Science and Engineering.—Vice-president, President Chas. S. Howe, Case School of Applied Science; secretary, G. W. Bissell, Michigan Agricultural College, East Lansing, Mich.

Section E—Geology and Geography.—Vice-president, Professor Bohumil Shimek, State University of Iowa; secretary, Dr. F. P. Gulliver, Norwich, Conn.

Section F—Zoology.—Vice-president, Professor Henry F. Nachtrieb, University of Michigan; secretary, Professor Maurice A. Bigelow, Teachers College, Columbia University, New York City.

Section G—Botany.—Vice-president, Professor Frederick C. Newcombe, University of Michigan; secretary, Professor Henry G. Cowles, University of Chicago, Chicago, Ill.

Section H—Anthropology and Psychology.—Vice-president, Professor George T. Ladd, Yale University; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

Section K—Physiology and Experimental Medicine.—Vice-president, Professor William T. Porter, Harvard Medical School; secretary, Professor George T. Kemp, 8 West 25th St., Baltimore, Md.

Section I—Social and Economic Science.—Vice-president, Professor J. Pease Norton, Yale University; secretary, Seymour C. Loomis, 69 Church St., New Haven, Conn.

Section L—Education.—Vice-president, Professor Edward L. Thorndike, Teachers College, Columbia University; secretary, Professor C. Riborg Mann, University of Chicago, Chicago, Ill.

The Astronomical and Astrophysical Society of America.—December 27–29. President, Professor E. C. Pickering, Harvard College Observatory; secretary, Professor W. J. Hussey, University of Michigan, Ann Arbor, Mich.

The American Federation of Teachers of the Mathematical and the Natural Sciences.—December 27–28. President, Professor C. R. Mann, University of Chicago; secretary, Eugene Randolph Smith, Polytechnic Preparatory School, Brooklyn, N. Y.

The American Chemical Society.—December 27–30. President, Professor Alexander Smith, Columbia University; secretary, Professor Charles L. Parsons, Durham, N. H.

The American Society of Biological Chemists.—(Baltimore and Washington.) December 27–29. President, Professor Lafayette B. Mendel, Yale University; secretary, Professor A. N. Richards, University of Pennsylvania, Philadelphia, Pa.

The Society of American Bacteriologists.—December 27–29. President, Professor F. P. Gorham, Brown University; secretary, Charles E. Marshall, East Lansing, Mich.

The American Physiological Society.—(Baltimore and Washington.) December 26–29. President, Dr. S. J. Meltzer, Rockefeller Institute for Medical Research, New York City; secretary, Professor A. J. Carlson, University of Chicago, Chicago, Ill.

The Geological Society of America.—December 27–29. President, Professor William Morris Davis, Harvard University; secretary, Dr. Edmund Otis Hovey, American Museum of Natural History, New York City.

The Association of American Geographers.—December 28–30. President, Professor Ralph S. Tarr, Cornell University; secretary, Professor Albert Perry Brigham, Hamilton, N. Y.

The Paleontological Society.—December 28–30.

President, Professor William B. Scott, Princeton University; secretary, Dr. R. S. Bassler, U. S. National Museum, Washington, D. C.

The Entomological Society of America.—December 26–27. President, Professor Herbert Osborn, Ohio State University; secretary, Professor Alexander D. MacGillivray, University of Illinois, Urbana, Ill.

The American Association of Economic Entomologists.—December 27–29. President, Professor F. L. Washburn, St. Anthony Park, Minn.; secretary, A. F. Burgess, Melrose Highlands, Mass.

The American Microscopical Society.—December 29. President, Dr. A. E. Hertzler, 402 Argyle Building, Kansas City, Mo.; secretary, T. W. Galloway, Decatur, Ill.

The Botanical Society of America.—December 26–29. President, Professor William G. Farlow, Harvard University; secretary, Dr. George T. Moore, Botanical Garden, St. Louis, Mo.

The Society for Horticultural Science.—December 29. President, Professor S. A. Beach, Ames, Ia.; secretary, C. P. Close, College Park, Md.

The American Phytopathological Society.—December 27–29. President, Professor A. D. Selby, Wooster, Ohio; secretary, Dr. C. L. Shear, Department of Agriculture, Washington, D. C.

The American Nature-Study Society.—December 27–28. President, Professor Benjamin M. Davis, Miami University; secretary, Dr. Elliot R. Downing, University of Chicago, Chicago, Ill.

The Sullivant Moss Society.—December 28. President, Dr. Alexander W. Evans, Yale University; secretary, Mrs. Annie Morrill Smith, 78 Orange Street, Brooklyn, N. Y.

The American Fern Society.—December 29. President, Dr. Philip Dowell, Port Richmond, N. Y.; secretary, L. S. Hopkins, Peabody High School, Pittsburgh, Pa.

The American Anthropological Association.—December 27–30. President, Dr. J. Walter Fewkes, Bureau of Ethnology; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-Lore Society.—December 28. President, Professor Henry M. Belden, University of Missouri, Columbia, Mo.; secretary, Dr. Charles Peabody, Peabody Museum, Cambridge, Mass.

The American Psychological Association.—December 27–29. President, Professor Carl E. Seashore, University of Iowa; secretary, W. Van Dyke Bingham, Dartmouth College, Hanover, N. H.

The Southern Society for Philosophy and Psychology.—December 28–29. President Dr. S. I. Franz, Government Hospital for the Insane, Washington, D. C.; secretary, Professor R. M. Ogden, University of Tennessee, Knoxville, Tenn.

The American Economic Association.—December 27–30. President, Professor Henry W. Farnam, Yale University; secretary, Professor T. N. Carver, Harvard University, Cambridge, Mass.

The American Statistical Association.—December 27–30. President, Frederick L. Hoffman, Newark, N. J.; secretary, Carroll W. Doten, 491 Boylston Street, Boston, Mass.

The American Sociological Society.—December 27–30. President, Professor Franklin H. Giddings, Columbia University; secretary, Professor A. A. Tenney, Columbia University, New York City.

The American Civic Alliance.—December 29. President, Dr. John Franklin Crowell, 44 Broad St., New York City; secretary, Dr. Gerald van Casteel, 80 Wall St., New York City.

The American Association for Labor Legislation.—December 28–30. President, Professor Henry R. Seager, Columbia University; secretary, Dr. John B. Andrews, Metropolitan Tower, New York City.

The American Home Economics Association.—December 27–30. President, Miss Isabel Bevier, University of Illinois; secretary, Benjamin R. Andrews, Teachers College, Columbia University, New York City.

PRINCETON, N. J.

The American Society of Naturalists.—December 28. President, Professor H. S. Jennings, The Johns Hopkins University; secretary, Professor Charles R. Stockard, Cornell Medical School, New York City.

The American Society of Zoologists.—December 27–29. President, Professor H. V. Wilson, University of North Carolina; secretary, Dr. Raymond Pearl, Maine Agricultural Experiment Station, Orono, Me.

The Association of American Anatomists.—December 27–29. President, Professor George A. Piersol, University of Pennsylvania; secretary, Professor G. Carl Huber, 1330 Hill Street, Ann Arbor, Mich.

NEW YORK CITY

The American Mathematical Society.—December 27–28. President, Professor H. B. Fine, Princeton University; secretary, Professor F. N. Cole, 501 West 116th Street, New York City.